THE

AGRICULTURAL BULLETIN

OF THE

FEDERATED MALAY STATES.

No. 8 & 9.] MAY and JUNE, 1917. [Vol. V.

PESTS AND DISEASES.

Visit to Laboratories.

ON the occasion of the visit to the Offices of the Department of Agriculture on the 26th April, an inspection was made of the laboratories, a description of which is given below:

Mycological Laboratory.

A number of specimens of diseases had been prepared and arranged by Mr. W. N. C. Belgrave (Acting Mycologist) and Mr. F. de la Mare Norris (Assistant Agricultural Inspector) the exhibits, in addition to specimens of parasitic fungi, included several of the common saprophytes, *e.g.*, several *Xylaria* sp., often found on decaying timber.

Among the parasitic fungi, there were specimens of pink disease in all its stages, die-back (*Diplodia*), thread-blight, *Ustulina zonata*, including all the different forms of fructification, *Poria*, *Fomes*, including a very fine resupinate fructification, brown root disease, *Sphærostilbe repens*, and black stripe canker. Particularly interesting was a specimen of an old tree attacked by "black stripe" into which the disease had penetrated to a depth of six inches.

Visitors were also shown pure cultures of most of the above fungi, and the method of making them.

Entomological Laboratory.

Exhibits prepared by Mr. P. B. Richards (Acting Entomologist) and Mr. C. B. Holman-Hunt (Systematic Entomologist) illustrated the common pests of cultivated plants in Malaya, the different stages in the life histories of the more important insects being displayed. The classification of the white ants was illustrated by a series of microscope preparations, while the structure of the nest, the social organization and the habits of the white ant of rubber, *Termes gestroi*, were demonstrated in some detail.

From the general insect collection cases were prepared to illustrate the classification of the Insecta, and considerable interest was shown in an exhibit of curious and rare insects.

CLEAN CLEARING, PESTS AND DISEASES.

By W. R. Shelton-Agar,
(*Manager, Kamuning Estate, Perak, F.M.S.*)

If I were asked to classify the various diseases and pests according to their relative activity in regard to rubber plant life, I should put disease into two classes—

(1) "Those that are fatal";

(2) "Those that are amenable to treatment";

and pests into both, *viz.*:

Fatal class (I).	Amenable class (II).
All root diseases—such as *Fomes*, *Hymenochæte*, *Ustulina* and *Poria*.	Stem and bark diseases—such as pink disease, *Diplodia*, thread blight and cankers.

Pests—*Termes gestroi* and borers.

I do not include vermin, as most wild animals, so far as rubber is concerned, could be classed as such and measures to deal with them, as a rule, are easily attended to.

As it will be impossible in a paper of this kind to deal individually with them all, I shall merely offer, for discussion categorically, four salient points:

Prevention;	Incidence and
Treatment;	Control.

Prevention of Disease.

So long as there is "no cure" for any fatal disease, obviously the next best thing is prevention.

Now prevention in this case means eliminating causability, or, in other words, having reference to all the fatal diseases and pests of class one.

The argument in favour of "clean clearing" is not mere theory, it has a practical side as well. Take those rubber estates that have been developed out of old tobacco, tapioca and lalang lands, they rarely give evidence of any appreciable trouble, and though we have these practical illustrations, timber clearing has never yet gained the whole-hearted support it merits. In some cases it is undoubtedly a matter of £ *s. d.*, but in others it is not so. Some planters hold that "by clearing timber much valuable humus matter is lost," and also that "no immunity exists from pests and disease so long as the roots and stumps of trees are allowed to remain in the ground."

These are admittedly weighty views, and the arguments are correct up to a point.

On the first point there is no doubt at all. One has only to turn over any old log, to see the countless feeding rubber rootlets that are gormandizing on the available collection of vegetable humus matter. Also memory still lives in regard to other agriculture, such as tea, coffee, etc., in which the best fields were always those that were most heavily timbered.

In rubber, however, we have to remember that decomposing or rotten timber is not only a hot-bed of infection but a nursery as well for the spread of fungoid diseases. *Poria* and *Ustulina*, for instance, are among the principal agencies that cause decay. Further, by leaving undestroyed timber and stumps of the "meranti," "merbau," and "kompas" type, we are only offering homes for the development of *gestroi* and borers.

What is the best way, then, of getting rid of one's timber?

I think, when opening up new land, we should adopt a "double-felling" method, after the style of old Ceylon coffee planters, *i.e.*, allow the clearing to grow up again for a year after the first felling. Then re-fell and burn off. The result of this operation ensures a thoroughly clean burn and, in view of our present-day knowledge, it seems to me that, in the case of rubber, this is essentially what is required.

As regards the second contention, mere up-rooting of small stumps does not present serious difficulty. Nor is it highly expensive. But to pull out and root the boles of large trees is costly and might run almost into any figure. In fact, to tackle really big stuff is financially prohibitive.

What, then, is one to do? In such cases, to my mind, there is only one practical course of action, *viz.*, isolate the bole by trenching (a distance of three feet is good enough) and if possible "run" any big lateral.

As a rule, two years after the original burn will see most of the soft woods in a state when they can be "fired," and in another two to three years only the very hardest will remain. If then "firing" operations are taken in hand at the times mentioned and steadily kept up, no great initial expense should be incurred to secure satisfactory destruction.

Now in regard to cost. Up to what point is one justified in incurring expenditure? There is only one way to answer this, and that is to apply the "will-it-pay" test. Let us take the two principal items of estate costs, *i.e.*, weeding and tapping. In my experience, there are few heavily-timbered fields that have cost less than $1.05 per acre per month (average) to weed during the first five years. Had they been free of timber, I should have put their cost at an average of 80 cents or less. This represents a saving of $15 per acre.

Then as regards tapping. The increase any tapper can do is at least a $\frac{1}{10}$th larger task on clean-cleared land. Put this into figures over the first five years of tapping and another saving of $18 per acre will be realized. That is, a total of $33 per acre on *two items* only; in the first five years of each period.

The following example should explain what is meant:

WEEDING.

	(A) Cost per acre per month.	(B) Cost per acre per month.
1st year average ...	$1.50	$1.25
2nd „ ...	1.25	1.00
3rd „ ...	1.00	.75
4th „ ...	.75	.50
5th „ ...	.75	.50
Totals ...	$5.25	$4.00
Average	$ 1.05	$ .80
Gross cost, five years ...	63.00	48.00
Saving per acre in five years		15.00

NOTE.—(A)—Uncleared of timber.
(B)—Free of timber.

TAPPING.

Task per cooly, 364 trees + 1/10th = 400 trees.

At 100 trees per acre labour required 1 $\frac{1}{10}$ cooly = (4 acres) = one cooly.

COST.

At 40 cents wages (say 30 days)	$ 13.20 p.m.	$ 12 p.m.
Gross cost, five years...	$\frac{792}{4}$ ...	$\frac{720}{4}$
Actual cost per acre ...	198 ...	180
Saving per acre in five years	...	18

The above are obviously "arbitrary" figures, but are reasonably arbitrary. They are not exaggerated instances.

This matter of saving could be still further carried down, *i.e.*, saving in cooly labour, housing, medical, etc., but enough, I think, has been said to show that from the financial stand point, a considerable sum of money can be outlaid profitably—profitably not only in the sense of benefit to our production cost, but to the ultimate benefit of the estate, by improved plant sanitation.

Treatment of Disease.

To be effective, treatment ought not to be merely a combative measure. It should also be curative. On this principle I have based my classification.

So far as the subject has reference to those diseases and pests that I have classed as "amenable to treatment" I only intend to touch on a few of the more important, *i.e.*;

(1) *Phythopthora*, because, to my thinking, canker is about the nastiest thing we have to contend with;

(2) Pink disease, because of the application of different methods;

(3) *Gestroi*, in regard to the use of pumps.

(1). *Phythopthora*. The ordinary planter knows it under three headings:

(*a*) Black line or black thread canker;

(*b*) Bark rot (claret canker);

(*c*) Leaf and pod disease.

Whether these three are all one and the same matters little. The fact remains, they are so closely allied, that curative and preventive operations (to be successful) should be worked conjunctively and as part of the same scheme.

In regard to black thread canker: estates in Burma have furnished us with most experience, and from my knowledge of them and from what I have seen there it is my opinion, that this disease can be effectively dealt with, by adopting a combination of rules as follows:

(1) No tapping on any very damp day;

(2) Decrease frequency of tapping on any field so attacked, as progress of disease is checked on cessation of tapping or by dry weather.

The more constant the opening of a wound the more susceptible and receptive it becomes, as black thread canker is a wound parasite and it attacks the delicate tissue exposed by tapping.

(3) The immediate painting of all diseased parts or wounds with Jodelite, which gives a sort of protective covering by systematic painting on a monthly round;

(4) Sanitation firing, *i.e.*, systematically burning all leaves and droppings; and

(5) Above all things avoid cambium wounding, which means no deep tapping.

Chiselling the disease out of a tree is not looked upon with any favour in Burma, and I personally share this view, also shared by H. C. Pratt. This does not refer to burr and nodule removal and if the painting mentioned elsewhere is put in—Jodelite—any of them will penetrate this and destroy it. If the disease is so bad as to

require the adoption of this method, the tree had better come out altogether, for, in the majority of cases, a healthy tree will throw off a slight attack.

This criticism I would also apply to bark rot or claret canker, which, in nine cases out of ten, escapes notice until too far gone.

When leaf, pod or branch canker occurs cutting out or lopping off and burning affected parts, followed by sanitation firing and changkolling, offers to my mind the soundest treatment.

Another alternative is to lime and bury the fallen deposit.

In Ceylon, again, research work lays great stress on the value of cultivation. And another recommendation, also from Ceylon, is to make a thorough inspection and clean out all dead branches and parts, etc., just after wintering is over. This, in my opinion, is very sound.

(2) *Pink disease.*—In the treatment of this disease, Federated Malay States planters follow two schools of thought. We have the "painters" and the "surgeons" and each "grinds an axe" of plausible argument.

Which method is correct? Personally I lean to the surgical operation and opine that the knife should be used in all but exceptional cases. My observations are that where painting is the vogue, such estates never seem to get free of the disease, whereas, where the knife has been liberally used, conditions are nearly always reversed even on estates in the same district.

(3) *Gestroi.*—Though machines for pumping and distributing arsenical fumes for the destruction of *gestroi* are most useful and efficacious, alone they do not constitute a cure—that is a cure in the sense of ridding an estate of this pest. Termitariums have to be searched out and destroyed, and as these are invariably located in logs or stumps and a *sine qua non* to successful operation is the removal of timber, etc. Where the pump is most useful is in dealing with the rubber tree itself.

Any attacked tree that is "pitted" and shows "tears of latex," means *gestroi* inside and also borers, but there is always a difference which is easily ascertained. The latter's droppings are always visible. Therefore, use an "augur" on it. Bore a hole first and then pump. Afterwards plug the hole with a bit of hard wood dipped in Jodelite, cut off flush with the tree, and tar.

There is nothing difficult in the actual use of the machine, but it is important to see:

(1) That the correct mixture is used;

(2) That a "red" fire is in the brazier;

(3) That each tree or log gets a thorough drenching, giving five minutes pumping to each dose of mixture put in the brazier, and not less than five to six doses per tree;

(4) Always carry an augur and don't be afraid to use it.

On peaty lands or soils that crack, pumps are useless. In such cases there is no alternative but to apply Towgood's system of search for termitariums, *vide* H. C. Pratt's "Observations on *Termes Gestroi*."

The external application of sundry poisons or forking insecticides into the ground at best only affords temporary relief.

In the matter of wound protection, my experience is that borers have no regard for tar at all; while on the other hand "jodelited" wounds are nearly always immune from attack. The most successful covering I have used is a combination of the two, *i.e.*, Jodelite as a first coat and tar as the next.

Incidence of Disease.

If we could forecast accurately the incidence of development and if we knew exactly when to expect the appearance of certain types of disease, this would go a long way towards solving many planting difficulties. For instance, we should know, the approximate period of time available wherein to complete preventive measures and also up to what point initiating a process of treatment would be valuable. With greater knowledge on this point, each estate would have a better chance of working out its own salvation. At present, unfortunately, we have little to guide us other than individual observation, which, of course, is unsatisfactory to base any working-rule on. As a beginning I record below my own ideas on their sequence and incidence.

(1) *Hymenochate*—

Generally occurs during 1st year. Occasionally also in 3rd year, but not often.

(2) *Fomes and Diplodia*—

Commence end of 2nd year and seldom seen after 4th year (if treated). Greatest activity immediately after rainy season. *Fomes* development is rapid.

(3) *Pink disease*—

Appears early 3rd year. There is a pink and black variety. Both are inimical and are always constant. Activity is most noticeable during rains immediately following dry weather.

(4) *Ustulina and Poria*—

Rubber fatalities do not often occur under eight to ten years old and, as a rule, trees are older. Both diseases are slow in development. Attacked rubber yields well for several years until the trees "snuff out."

(5) *Black line canker* or *black thread disease*—

May be looked for in the first year of tapping and is more serious when tapping on renewed bark. Most active in damp weather.

(6) *Claret canker*—

As a rule, found on trees 10 to 15 years old. (*See* No. 5 remarks.)

(7) *Leaf and pod disease*—

Attacks rubber of any age and is most active after a spell of rain. Irregular defoliation of young rubber, such as "double-wintering," etc., is suggestive and should always be carefully examined.

Control of Disease.

This is where, I think, our planting system fails. Most planters have a "nodding" acquaintance with the history and treatment of the various disease and pests common to the country, but, is this sufficient? Take the generality of estates out here. They rely almost entirely on the planting manager. He does his best "according to the book," but, is it satisfactory in reality? Consider too, that each manager in turn relies on a working-cooly gang very briefly supervised. Is it not possible that something really essential has been missed or left undone? Is a system controlling scientific work based on such lines correct? It is true, our losses from all causes of pest and disease would probably never total what we have had to thin out, but is that adequate insurance against the future?

"We planters are not 'rubber doctors.'" I have even heard it said that we are only "crude agriculturists," which is probably true, because the economic equation to our training is the "almighty cost per lb." or "cost per acre" as the case may be. Therefore, if we are to keep up with a science that daily claims a larger share in the ethics of present-day planting methods, and if we are successfully to apply these teachings, ought there not to be on every estate a co-ordinate staff of some kind trained for field operations if not in actual control?

We have already group hospitals and group doctors. Why not mycologists?

This is the most effective means of getting into close contact. A man who is on the spot can devote his attention to things. A visiting mycologist only touches the surface. This could be further elaborated by kranis, overseers, and conductors, being taught a certain amount of practical work in technical schools. In India, I believe, a great deal has been done and they turn out some very good men. What we want are such men who would take up a position in the working staff, correlative with doctors, dressers, attendants, etc., in the medical line. This slap-dash, easy-going method of ours is all wrong, and I believe the industry must waken up sooner or later to this.

DISEASES OF THE LEAVES AND STEM OF HEVEA BRASILIENSIS IN THE MALAY PENINSULA.

By R. M. Richards, A.R.C.Sc.

(*Mycologist, M.P.A. Association.*)

HITHERTO the tree from which plantation rubber is obtained has not suffered from any serious epidemic disease. Only a purely parasitic fungus which would favour Hevea as a host is likely to cause an epidemic disease and it is those parts of the tree above ground which would be subject to infection. Root diseases have been and are serious enough on some estates but it is a fact that the various fungi, which cause diseases of the root system of Hevea in this country are preventable—that is to say, by certain means, whether they be considered impracticable or otherwise, it is possible to create conditions which exclude the chance of infection.

It is quite another matter, however, to prevent air-borne spores of a parasitic fungus from affecting parts of the tree above ground. I do not wish to infer that it is not possible to prevent serious loss from attacks of air-borne diseases for no unsurmountable difficulty has been encountered in dealing with the diseases of the leaves and stem known to us up to the present time.

The Para rubber tree in this country has so far shown itself to be a particularly healthy plant, but let it be realized that only by the treatment of diseases as they appear can we hope to keep up to this standard. The planting of enormous tracts of contiguous areas with the one kind of plant renders conditions ideal in this country for the rapid propagation of disease and only by careful vigilance in the treatment of disease and by the immediate adoption of remedial measures can the rubber plantation industry keep its position of security.

Where planted areas have suffered severe loss through disease up to the present time, in the majority of cases this loss has been due to carelessness or indifference, to the adoption of unsound methods of plant sanitation owing, possibly, to false ideas of economy, to the want of expert assistance at the time when the trouble arose or to begrudging money for treating disease.

In Ceylon a species of *Phytophthora* causes an abnormal leaf-fall during the wet weather from July to September. The fungus is said to spread from diseased fruit pods to the leaf stalk. The attacks on the leaf stalk appear to cause the production of an abscission layer at the base of the leaf stalk and so cause the fall of the leaf. In wintering seasons the abscission layer is normally

produced to effect defoliation. So far this abnormal leaf-fall has not been recorded, or at any rate I have not seen any cases of it, in this country.

The leaves of nursery plants are attacked by several fungi but none of them are serious and I do not consider it necessary to describe them in detail here.

Two fungi are commonly found on leaves which turn brown or yellow at the edges, *Gleosporium albo-rubrum* and *Phyllosticta ramicola*. These will be referred to later in considering stem diseases. They do not cause serious diseases of the leaves.

Cephaleuros sp.

This alga which is found commonly on the under sides of leaves where it produces small brown spots has no economic importance. The "red rust" of tea, a serious disease in India, is caused by a similar *Cephaleuros*. It is worth noticing in passing that such an alga has been found penetrating the leaf tissue of Hevea as most diseases associated with the tea plant are also common to Hevea.

No leaf diseases have any economic importance. Fortunately, no fungus belonging to the family *Uredineæ* has been found on Hevea leaves. It is to this family that *Hemileia vastatrix*, the cause of the well-known coffee leaf disease which ruined the cultivation of coffee in Ceylon, belongs. It is quite possible that a member of this family might adapt itself to the leaf of the rubber tree and might even have equally devastating effects as *Hemileia* in Ceylon but at the present time that does not seem probable.

The consideration of leaf diseases need not keep us any longer. Owing to the particular nature of the leaf it is, perhaps, naturally not particularly suitable as the host for parasitic fungi.

DISEASES OF THE STEM.

Of the stem diseases now recorded in this country the most serious are those caused by *Corticium salmonicolor* (pink disease), *Phytophthora faberi* (bark canker), *Phytophthora* species (causing decay of the tapped surface) and *Botryodiplodia theobromæ* (die-back).

Other fungi causing disease are *Phyllosticta ramicola*, *Gleosporium albo-rubrum* (forerunners of die-back), *Cyphella heveæ* (thread blight) and the abnormal condition of the stem, which I must include here, caused by burrs.

Pink Disease (*Corticium salmonicolor*).

In Java and in this country this disease is exceedingly common. The disease was very fully investigated in Java by Zimmerman, Zehnter and Rant, and in this country by Brooks and Sharples. The literature obtainable on this subject is considerable and in compiling a summary for purposes of discussion I must point out that this literature gives a very complete account of the disease.

South, the Agricultural Inspector, Federated Malay States, in December, 1915, published a paper on the "Distribution and Field Treatment of Pink Disease" in the *Agricultural Bulletin*. In this paper we are told that the disease was then known to exist on 154 estates (of over 100 acres in extent) in Perak, Negri Sembilan, Selangor, Pahang and Johore. I can add that the disease is not unknown in Province Wellesley and Kedah. It is true that there are certain limited areas where the disease is much more common than in other parts of the country but since 1913 it has become much more widely spread.

It is sometimes observed that when the main stem or large branches are attacked the fungus apparently dies during a spell of dry weather and the affected bark cracks and dries up and a lip or callus forms on the healthy bark at the margin of the wound. In some cases the disease is thrown off in this way but more often it begins to develop again as more suitable conditions, rainy weather, arise. The disease first appears sporadically, that is, isolated affected trees are found here and there in the planted areas but unless checked it soon begins to spread.

Various methods of treatment have been tried and among these I have found only one which I consider successful. Spraying with fungicides need not be discussed at all as it is quite impracticable as a method of treatment of affected trees. If it were considered that the disease might cause a serious epidemic then spraying might have to be undertaken as a preventive measure.

Brooks and Sharples considered that the best method of treatment was the application of tar to the affected parts of the bark. South in an article to which I have already referred (published December, 1915) stated "The year's additional experience has, however, shown all the officers of the Agricultural Department connected with this work that the treatment originally recommended by the Mycologists is not sufficiently vigorous and drastic. More cutting and less tarring is generally advisable, while the pest gang should be large enough to make one complete round each fortnight or at the very longest every three weeks." Mr. South may have changed his opinion since then but the conclusions which he arrived at at this date do not appeal to me at all. I think the better treatment is the covering of affected parts of branches with a mixture of tar and crude oil (80 per cent. tar to 20 per cent. oil).

The whole circumference of the bark well above and well below the area affected should be covered with this mixture. If the disease is found in its early stages the application of the mixture checks its progress and actually in practice no further treatment is necessary in a very large percentage of cases. Should the treatment not be successful the branch may be cut off but only after treatment.

The very drastic method of cutting away affected branches which more often than not means cutting off the top of the tree or a well developed branch affected by a spore-producing fungus tends to accelerate the dissemination of the spores. If any cutting away has to be employed the tar and oil mixture should be applied first.

The oil is mixed with the tar to prevent drying and not because this mixture has any more penetrative power than tar only. After using this method of treatment for nearly two years I am quite satisfied, and I am sure many planters who have adopted the method will agree with me, that it is the only method of treatment which is at all satisfactory.

I agree with Brooks and Sharples in their statement in Bulletin No. 21 of the Department of Agriculture that "where a considerable amount of 'pink' disease is present one can scarcely expect to eradicate it completely" but it is possible by treatment not only to check the spread of the disease but also to effect a cure without the loss of branches which are essential for the production of good yields of rubber.

Individual estates can check the spread of the disease from within but frequently there are neighbouring estates and kampongs where the disease is not treated equally well and it is impossible to check the disease to the extent one could wish.

I am of the opinion that the treatment of the disease in native holdings and kampongs needs revision. Pink disease has increased very considerably during the past three years and I think this is mainly due to the fact that it is not under control in districts where it is rife and I am one, among many, no doubt, who attribute renewed outbreaks to fresh infections from outside sources, chiefly from native holdings.

It is absolutely essential to employ a pest gang constantly on all plantations where pink disease has been discovered if any real results in checking the disease in the country are to be obtained.

Die-back (*Botryodiplodia theobromæ*).

The fungus which after pink disease has up to the present caused the greatest amount of injury to the parts of the tree above ground is the disease which, because of the way in which it travels down the tree killing the branches and main stem in its progress, has been called and is known as die-back.

Botryodiplodia theobromæ may make its attack in a variety of ways; the commonest method, as far as my experience goes, is to enter young shoots killed by two parasitic fungi, *Phyllosticta ramicola* and *Glœosporium albo-rubrum*, or by one of these; but it may enter a wound of any kind. The fungus appears to be

essentially a wound parasite whether the wound which affords the place of entry is associated with the attack of another fungus such as those just mentioned or *Corticium* or whether the wound be caused by a dead twig or broken branch. However the entry is effected the hyphæ begin to spread downwards in the tissue in the young wood or young bark, that is near the position of the cambium, killing the tree in a characteristic manner. It has generally been my experience to find groups of trees affected together, usually small groups.

On one estate I recall an occasion on which 150 trees of seven years old were found affected in one group. A few of these trees, not more than six, were killed but many of the others had to be cut back below the fork. Usually one tree is found killed and a group of trees in the immediate vicinity more or less seriously affected.

The only method of treatment is to cut down all trees killed by the disease and to remove all affected branches of trees which have not suffered so severely. However slight the attack the affected parts must be removed. All attacked parts of trees should be destroyed by fire immediately. It is necessary to act immediately when dealing with this disease as it develops and spreads down the tree with great rapidity. Dead rubber trees and branches should not be allowed to remain lying about in plantations. Any part of a dead rubber tree affords a most suitable place for the development of the fungus and indeed it can almost invariably be found on dead rubber branches or stems.

During the time I have worked in Malaya I have not been able to find the stage described by Bancroft as the ascus stage in the life history of the fungus which he considered to be the higher stage of *Botryodiplodia* and for this reason re-named the fungus *Thyridaria tarda*. There is no confirmation of the existence of such a form and until Bancroft's work is confirmed *Botryodiplodia theobromæ* as a name has the prior claim.

Phyllosticta ramicola and Glœosporium albo-rubrum.

For the purposes of this paper these two fungi may be dealt with together as they are frequently intimately mixed on the same affected branch or twig. The two fungi are parasitic and usually affect the uppermost twigs which still have a green epidermis or skin—that is, where cork has not yet been formed.

Phyllosticta generally makes its attack at a point 6 to 18 inches below the apex of the shoot. When first noticed a brown patch may be observed which later spreads upwards and downwards killing the twig. Usually the fungus spreads no further down than two to three feet below the apex. *Glœosporium* has a similar mode of attack. It is usually immediately after wintering when the leaves are just

unfolding that the attacks of these fungi occur most commonly. I have seen several thousand trees affected on one estate within a few weeks. *Glœosporium* is frequently the cause of the fall of the young leaves before they are fully developed—an effect of not uncommon occurrence.

As far as these two fungi are alone concerned the attacks are not dangerous. Dead twigs killed by the fungi are often found but the disease spreads no further. The real danger lies in the fact that their attacks afford opportunity for the entrance of *Botryodiplodia* and for this reason affected branches should be removed and all diseased portions burned.

More often than not, especially in flat lands, *Botryodiplodia* makes its entrance after the attacks of these fungi and therefore it is necessary that the utmost precautions should be taken to prevent a serious local epidemic of die-back.

Thread-blight.

The mycelial strands of this fungus appear like white threads running along the small branches and twigs of affected trees collecting and binding together leaves in bunches. Leaves are frequently killed and sometimes small branches. The bunches of dead leaves and leaf stalks found bound together by the threads render the fungus conspicuous.

Dead leaves or collections of leaves may be broken off and carried by wind or some other agency to other healthy trees where the fungus may start developing again and so spread the disease. Leaves of two trees may, so to speak, be sewn together by the threads and this is another way of spreading the infection.

Fortunately, the disease is easily treated by cutting away affected parts and as generally only small branches are attacked the loss occasioned is insignificant.

On one plantation I found this fungus in fructification and sent it to Kew for identification where Massee named it *Cyphella heveæ*, but this is a matter which required further evidence or confirmation before we can be satisfied that the fungus belongs to this particular genus.

Phytophthora species.

Here I come to the most important part of my paper. In Ceylon, South India, Burma, Java and Sumatra a disease known as canker and proved to be caused by *Phytophthora Faberi* has been known for several years. The disease was found in Ceylon in 1903. In January last I heard that on a certain estate a disease had appeared on the tapped surface. Through the courtesy of the manager I was permitted to look round the estate and it was obvious at once that the disease was extremely serious for in 500 acres of well-matured rubber tapping had ceased. I was not able to

obtain any material to work on for all the affected trees had been subjected to treatment. In February again, through the kind permission of the manager, I was able to visit another estate 200 miles away from the first where apparently a disease of a similar nature had occurred. Sharples, the Government Mycologist, was visiting this estate and he isolated the fungus *Phytophthora* from the diseased bark. Within a day or two I visited an estate which it is my privilege to visit regularly and there found a considerable number of trees with this same disease. I have now isolated the fungus from material collected. From evidence collected it appears that the fungus is not *Phytophthora Faberi* but another species of the same genus.

The disease is undoubtedly the same as that known as "bark rot" in Ceylon, "black thread disease of Hevea" in Burma, and one form of canker (vertical black line) in Java. Infection only takes place on the most recently tapped surface and, therefore, the fungus appears to be a wound parasite. Essentially the disease is a decay of the tapped surface. The most recently tapped bark immediately above the tapping cut shows vertical black lines varying in length up to one inch or more, and these on removal of the bark are shown to continue into the wood. This "bark rot" may spread and several "lines" of decay may coalesce to form small blackened or sometimes greyish, roughly rectangular areas of dead bark. Further, as the fungus develops several areas may coalesce, producing a decayed area of bark just above the tapping cut and right across the tapped area. Superficially the lines often appear as slits or vertical depressions some little distance above the tapping cut, but frequently, at an early stage, the lines may only be discovered by removing the thin outer-layer. As Dastur has pointed out the depressions may be due to the collapse of the cell walls of the outer tissues. Rutgers in Java, Dastur in Burma, and Macrae in India have proved that the decay of the tapped surface or "bark rot" is due to an infection of *Phytophthora*. That a species of this fungus is the actual cause of the decay is beyond all doubt since these three independent workers obtained positive results by infection experiments. That work has also been done in this country by Messrs. Belgrave and Norris in the Agricultural Department.

In Ceylon, Petch has shown that there are four different diseases caused by *Phytophthora Faberi*—namely, stem canker, "bark rot" of the tapping surface, abnormal leaf fall and pod disease, but recent evidence goes to show that more than one species of *Phytophthora* is responsible for these diseases.

Until January last I had not seen any sign of a disease caused by *Phytophthora* on any of the estates I visit regularly but I am inclined to think that the "bark rot" of the tapping surface is now extremely common in the country.

Bark canker.—The fungus causing this disease appears to be *Phytophthora Faberi*; there being then two distinct forms of disease apparently caused by different species of the same genus. The fungus was known to cause a canker on Hevea as long ago as 1903 in Ceylon. In this country, however, as far as I am aware the disease has only recently been found.

Certainly on estates I visit I had not been able to attribute any pathological condition to the fungus *Phytophthora* until March of this year. The disease starts in patches usually on or near the tapped bark but they may appear at a higher level. It is possible that the first indication may be that the tree ceases to yield latex. If undiscovered at an early stage the decaying tissue will attract borers and the appearance of boring beetles may be the first visible sign. In all cases when latex ceases to flow the bark should be lightly scraped; if a green layer is found the tree is healthy. Sometimes, in the case of trees with a very scaly outer bark, the green layer is not very obvious. If the tree is attacked by the fungus *Phytophthora Faberi* a black layer is found on lightly scraping and the cortex beneath is variously coloured, greyish, brown or dirty red or purple red according to the stage in the attack, *i.e.*, it may be greyish in the early stage or may be very dirty red which changes to purple red on exposure in advanced cases.

The diseased patch usually has a well-defined dark border. No latex will flow from patches of cankered bark but surrounding bark may yield extraordinary quantities. It must be understood that the colour of the bark only applies to the internal layers of bark and that it can only be detected by scraping away outer layers. Usually there is no external indication of the disease. The disease is capable of spreading and may kill the whole bark from the point of attack to the position of origin of first branches or higher or all the bark of the main stem. Boring beetles are attracted by a peculiar smell, which appears to be characteristic of the cankered bark, and they may possibly cause more injury than the canker itself.

Treatment.—The red canker patches of bark canker must be excised or scraped if patches can be found where the disease has not affected the inner tissue to the cambium and the wounds so caused painted with a 20 per cent. solution of brunolinum in water and soft soap and later covered with coal tar. It is useless trying to apply any form of treatment in the case of badly affected trees where boring beetles have made their entry into the wood. These trees should be cut out and burnt.

As regards the treatment of "black thread disease" or the "bark rot" of the tapping surface I will here indicate methods advised by other economic mycologists in various countries.

Rutgers and Arens in Java suggest that "tapping be stopped and the cuts treated every five days with a 20 per cent. solution of

carbolineum or some other disinfectant. After a few weeks tapping can be started again; in some cases it is not necessary to stop tapping." As preventive measures they point out that free access of air and light should be given to the trees in the plantation by thinning out, that there should be a thorough system of drainage and the use of water in tapping should be avoided.

Dastur, who did the work on the disease in Burma, suggests cessation of tapping at the first appearance of the disease and the collection and destruction of all diseased fruits.

In South India an effective method is said to be the cessation of tapping on affected trees and a mixture of tar and tallow smeared over the diseased area of bark.

Petch says "When the tapped surface shows signs of decay it should be brushed over twice a week for three weeks with a solution (20 per cent.) of brunolinum (brunolinum one gallon, water four gallons, soft soap one lb.) The canker patches must be cut out and the diseased tissue burnt."

I have not as yet been able to draw any very definite conclusions from the experimental treatment adopted on the various estates affected but hereunder I make suggestions which may be acted upon at once should the disease be found on your estate.

Prior to making suggestions it is necessary to understand the conditions which favour the growth and spread of the fungus. All species of *Phytophthora*, the potato disease of Ireland caused by *Phytophthora infestans* is one example, need excessive humidity for their development. Any particular cause which has the effect of preventing the drying up of moisture on the tapping or tapped surface should be eliminated if such elimination is possible. One cannot prevent rainfall but it is possible by one or more of several means to increase the rate at which the moisture on the bark will evaporate.

It does not follow that because a method of treatment is successful in one country it is necessarily a success in another country or another part of the same country because conditions, particularly atmospheric conditions, vary so considerably.

In Burma, for example, there is a distinct wet season and it is during this season that the disease is prevalent. In this country again it seems to me that the fungus, for some unexplained reason, penetrates more deeply into the tissues of the plant, to a considerable depth in the wood, than, from the information obtainable, in other parts of the East, where Hevea is planted. It would appear then that what may be an unavoidably drastic measure in one place could be extremely unnecessary in others even in the same country.

In all probability the disease is worst on closely planted estates, where, necessarily, the bark renewal of tapped surfaces is poor since the increase in girth is slow.

On estates where the spacing of the trees is adequate to allow for good growth and rapid renewal it is possible that the trees are able to throw off the disease.

If the rainfall is unusually excessive the spacing factor would obviously not have the same significance.

Although pruning is not recommended at all in the ordinary course of events as I consider it necessary to provide all possible leaf area and not to deprive the tree of any branch if it can be avoided, it may be necessary to prune in order to increase the distance between soil and foliage to allow for access of light and air where there are serious outbreaks of the fungus.

Water lying about on the surface soil would increase the moisture content of the atmosphere about the level of the tapping surface, preventing rapid drying and increasing the chances of infection. Should such a condition exist remedial measures should be adopted without delay.

It is not easy to give any definite reliable information on the treatment of the disease at the present time for the reason, as I have stated above, that sufficient time has not passed to allow one to draw any sound conclusions.

When trees are badly affected it would seem that superficial treatment with disinfectants would not check the disease as it could readily spread in the wood behind the cortex and bark could be re-infected at a lower or higher level. It would, therefore, be necessary to cut out the affected bark and possibly the superficial layers of wood—in any case all dead bark should be removed.

The tapped surface of slightly affected trees may be painted with a 50 per cent. solution of Jodelite (half Jodelite, half water) or even a stronger solution or a 20 per cent. solution of brunolinum twice a week for three weeks.

It may be necessary later on to cut out the diseased bark but such drastic measures should not be taken unless the other method fails, as the resulting wound is a serious matter.

In all cases tapping should cease on affected trees. I have not seen any evidence to prove that the disease is carried by the tapping knife but it is quite possible that that may happen. To be on the safe side it may perhaps be advisable to sterilize the tapping knives and for this purpose to use a 5 per cent. solution of formalin which should be carried by the tappers in receptacles of some kind large enough to hold the knife. After each tree is tapped the knife should be placed in the formalin solution.

Where the disease is serious it will be found necessary to apply a disinfectant to the tapped surfaces of every tree in the area. The infection takes place on the cut. That is on the thin bark most recently tapped. It is at this position then that the disinfectant must be applied. The most important questions are the frequency of application, the best disinfectant to use and the method most practicable in estate practice. From an article in the most recent *Agricultural Bulletin* I gather that in Sumatra it is found that the best results are obtained if the disinfectant is applied every day. From figures given in the article, by H. C. Pratt, to which I refer, it appears that this is the only satisfactory method. The disinfectant may be 20 per cent. carbolineum as used in Sumatra or its substitute 20 per cent. brunolinum, 10 per cent. Izal or a solution of sodium bisulphite and formalin. The last question—the most practicable method—may well be left for the planter to decide.

Burrs.

These structures are too well-known to need any description. Rutgers and Arens considered that they are produced as a result of attacks of *Phytophthora Faberi* but there is no indication of the presence of a fungus of any kind within the tissue of a burr or nodule.

Burrs are formed round a portion of a latex vessel as a result of alteration of the contents of a latex vessel. Whether that alteration be disintegration, decomposition or coagulation, cortical cells surrounding the latex vessel are stimulated to divide and form a cambium which cuts off wood cells on its inner side forming a core of wood tissue and bark cells on its outer side. The remains of the latex vessel are easily discovered when sections are examined microscopically. Similar nodules are produced as a result of latex oozing out of a tube or occupying spaces between the cells (intercellular spaces) or, occupying lesions in the cortex. Bryce divides these into three types, he distinguishes yet another type which I have not seen—namely, nodules which are formed round areas of cortex from which latex may be entirely absent.

I have not been able to find any evidence whatever that this pathological condition has any connection, directly or indirectly, with the attack of any fungus disease or insect pest.

Bryce suggests that "the tendency to suffer alteration in the latex vessel content appears to be confined to certain individual trees which have a predisposition to develop this condition."

I think myself that in a very large proportion of the number of burred trees the original central point (round which the burr develops) the factor which is the cause of the burr, is merely accidental, due to local coagulation or alteration of the latex within the tube or to the bursting of a tube allowing latex to occupy spaces where it is foreign.

ROOT DISEASES OF HEVEA AND CLEAN CLEARING.

By W. N. C. Belgrave, B.A.

(*Acting Mycologist, F.M.S.*)

THE interest taken in root diseases, which had waned with the control of *Fomes*, has been revived in the last three years by the discovery of *Ustulina* and *Poria* as common and destructive parasites of Hevea; and in some quarters something approaching a panic was experienced.

Still more recently, root diseases have been again overshadowed by bark cankers. Without minimizing the seriousness of the latter, it is to be urged that root diseases be not neglected—especially now that the policy of drastic thinning out has been widely adopted.

The fungus root diseases known to attack Hevea in Malaya are:

Fomes lignosus (*semitostus*).
Sphærostilbe repens.
Ustulina zonata.
Poria hypolateritia.
Brown root disease.—*Hymenochæte noxia.*

Of these, *Fomes lignosus* is the only one which regularly attacks young rubber. Although described since 1854, it was not till 1904 that its parasitic nature was recognized—by Ridley. Bancroft fully described the fungus and its mode of attack on Hevea in 1912. Like all root diseases an attack of *Fomes* is generally too far advanced when discovered, for the tree to be saved. The only signs of *Fomes* attack which show above ground are drying up of latex, and withering of leaves. The chief characteristic of *Fomes* is the production of external mycelial strands on the diseased roots. When young these are white, and much branched, becoming later cord-like and brown yellow, or reddish; and attaining a thickness of as much as ¼ inch. The mycelium under favourable conditions is capable of growing for short distances though the soil independently of roots. The most favourable conditions are moisture and acidity, hence in heavy clay or peaty lands, much more unattached mycelium will be found, than in looser drier soils. If the source from which the mycelium has started be removed, the hyphæ soon die, and no mycelium can be found after a lapse of a few days. It follows that once all the diseased wood has been removed from an infected area, there need be no fear of the "free" mycelium carrying on the disease.

The fructifications of *Fomes* are most frequently found on wet low-lying land. They take the form of brackets which may be

single or fused, and are, when fresh, of a brittle woody nature. On breaking across, the bracket is seen to consist of two layers, the upper of which is white and composed of fibres which run parallel to the surface, the lower bright orange coloured, and composed of tubes vertically arranged. The upper surface is zoned with alternate brown and pale yellow brown zones running parallel to the margin, while narrow wavy lines or striæ run at right angles to the zones. The margin, especially in young fruits is yellow, and the under surface is bright orange, studded with very small pores—the openings of the tubes mentioned above. The spores are borne on the sides of the tubes, and are shed from the pores. It must be mentioned, however, that the majority of the *Fomes* fructifications examined in this country are found to be sterile, *i.e.*, bear no spores, and cannot assist in the spread of the fungus.

The fructification may be found in another form—as a plate spread on the wood—the exposed surface being orange coloured. This form is known as "resupinate" and is not common.

The great majority of infections of *Fomes* arise from contact, of mycelial strands, or pieces of diseased wood, with healthy roots. Artificial inoculations carried out by Bancroft to prove this point were very successful, giving positive results in 10 out of 14 cases.

In the opinion of Bancroft, in Malaya the fungus occurs on all kinds of jungle timber, hard and soft, white and red; so the selective clearing favoured in Ceylon is unsafe here.

Attacks by *Fomes* are usually first detected at 12-18 months, and if properly treated, begin to diminish some time after the fourth year, owing to the decay of the jungle hosts of fungus.

Sphærostilbe repens.

This fungus was first recorded as a parasite on Hevea in 1907, in Ceylon; when it was found to have killed three 25-year old trees. Richards first recorded it in Malaya, and Brooks described it in the *Agricultural Bulletin* of November, 1914. In Malaya the disease has so far occurred on low-lying lands—Petch, however, states that in Ceylon it is not confined to low country.

Attacked roots are characterized by a blueish-purple colour and an extremely unpleasant odour. There is no external mycelium, but between the wood and bark run rhizomorphs—flat mycelial strands, red when young, turning black as they grow older. The disease sometimes travels up into the stem, after which borers often enter.

The fructifications of this fungus are very minute and easily overlooked. The form most frequently found is the conidial—*Stilbum* stage—consisting of white or pink blobs about the size of a pin's head, borne on stalks about $\frac{1}{8}$th inch long, and hairy when young—spores are formed at the ends of the blobs.

Brooks obtained pure cultures of the fungus, and carried out inoculation experiments on the roots of healthy trees. These were entirely unsuccessful and suggest that some condition adverse to Hevea must exist before the fungus can enter living roots. This condition may well be bad soil ventilation. Infection may be either by spore infection on wounds (on exposed roots) or contact with diseased jungle roots and precautions must be taken accordingly.

Ustulina zonata.

A disease first detected in Malaya in 1914 by Brooks—followed by Sharples—the latter author attaches more importance to the manifestations of the fungus as a collar-rot than as a root disease; but root attacks and spread by contact should not be neglected. Petch attributes the prevalence of the disease in Ceylon on tea to lateral root contact from stumps of *Grevillea* which had been left in the ground. The characteristics of an *Ustulina* attack are —a dry rot of the attacked wood, and the production of coarse interlacing black lines in the wood. There is no external mycelium and the wood must be cut into before the disease can be found. The fructifications are of somewhat varied form—the most common being a plate-like mass, adpressed to the collar of the tree—the colour of which changes from yellowish-white, through grey—white and greenish-grey to black. In the later stages, when splashed by mud, the fruits easily escape observation. More rarely other forms of fruit body are found, *e.g.*, a solitary stalked form; stalked forms aggregated to a plate; and other lichen-like forms. All, except the last, produce spores in abundance, which falling or being carried to wounds or cuts propagate the fungus. It follows that the fruit bodies of this fungus, like those of *Sphærostilbe*, should be destroyed as soon as found.

Brown Root Disease (*Hymenochæte noxia*).

So far this disease has not been recorded to any great extent in Malaya although Petch states that it is the commonest root disease of Hevea in Ceylon. Characteristic of this fungus is the production of hard, brittle, brown or black incrustation around infected roots—composed of soil bound to the roots by the fungus mycelium. Within the decayed roots are often found brown lines or plates of fungus tissue. Diseased wood, at any rate in Malaya, remains hard, but may become honeycombed. Fructifications are of very rare occurrence and are of no practical importance.

So far as I know, no artificial inoculations have been attempted with the fungus, but the disease can often be traced to a jungle stump. Brown root disease has usually been considered as not dangerous owing to its slow spread—the idea being that the attacked tree dies, and is taken out before the roots of the surrounding trees can be infected. This may be so, but it is better to be on the safe side, and to treat the disease like all other contact root diseases.

Poria hypolateritia.

This fungus, causing a wet-rot of Hevea was the subject of an article in the August *Agricultural Bulletin* for 1916. It appears since, that the specific name *hypolateritia* there given was not correct, and the fungus is nearer to one recently described by Petch in Ceylon as *Poria hypobrunnea*. The matter has been referred to Kew, and the final name will be settled by the authorities there. Whatever the systematic name, there is no doubt of the presence of the fungus, and of its characteristics, the chief of which is the wet rotting of attacked roots. This may vary from a slight dampness of recently attacked roots only discoverable on splitting, to the complete disintegration of the root to a jelly-like mass.

A very delicate snow-white mycelium is sometimes produced on the exterior, but no strands travelling through the soil have ever been found. The exterior of the root is sometimes covered by a very dark reddish skin of mycelium and bark tissues mixed; this skin is tough, and when freshly taken up can readily be detached from the wood—serving to distinguish an attack of this fungus from that of brown root disease; in the latter case the external crust is brittle and cannot be separated from the wood.

Brown lines or plates of hardened fungus tissue are often found. They differ from those produced by *Ustulina* in colour and texture, being much finer and less branched. Broad brown bands also occur, formed by the deposition of a substance akin to wound-gum. Attacks of *Poria* sometimes cause honeycombing of Hevea wood, but the phenomenon is more common when hard jungle woods are attacked. Like *Fomes* the fungus has been found both on hard and soft woods, including many of the largest stumps such as are very often left in otherwise cleared plantations.

Perfectly developed fructifications are very rare; more commonly on the under-side of exposed roots, small patches of an imperfect fructification develop. The fungus belongs to the same group as *Fomes*—and the fructifications have the same form as the resupinate form of *Fomes*, *i.e.*, a plate perforated with many fine holes. The colour is white when young, later becoming red-brown to black. These fructifications are sterile, *i.e.*, bear no spores, and cannot spread the disease.

It was first thought that the disease might be confined to special areas, particularly flat wet lands—but it has since been found to be distributed through the Peninsula.

The mode of infection is by contact of lateral roots with jungle stumps, or with other laterals; and the peculiar danger of the disease lies in its very slow rate of growth in living tissue, which makes it possible for neighbouring trees to be infected—through laterals—before the first infected tree is seen to be diseased. This insidious method of attack is further aided by the partiality of the fungus to

heart wood, which has ceased to function, and to the fact that it very seldom "rings" a tree but goes up to the collar on one side only.

In one field of rubber, 30 per cent. of the trees were affected by the disease before its presence was even suspected. The disease is usually discovered earlier on wet lands as owing to the poor development of the root system, attacked trees blow over sooner.

So far only one estate has had its young rubber badly attacked by *Poria*; this is not because young trees are immune to attack, but because the laterals take time to establish contact. Isolated cases can often be found on young rubber, and without doubt, many deaths formerly attributed to *Fomes* or brown root disease, were due to the then undescribed *Poria*.

Treatment.

With few exceptions treatment of individual trees is impracticable, as the diseases are never discovered till too late.

Attention must therefore be turned to prevention.

Prevention.—Is of two kinds: (*a*) Total prevention of attacks; (*b*) Prevention of spread from attacked areas.

It has been shown that all the root parasites of *Hevea* also live on dead wood, *i.e.*, can be saprophytes; and that it is from dead wood that infections arise. The obvious remedy is to remove all dead timber and stumps both of jungle and Hevea trees, *i.e.*, to adopt clean clearing: if this be done, it is not too much to say that immunity will be ensured from Brown root disease and *Poria*, while infections of *Fomes*, *Sphærostilbe*, and *Ustulina* will be reduced to those from spores blown or brought from neighbouring jungle or plantations.

It is usual to find that saprophytic fungi, which become parasites, can only do so by gaining an entry through a "wound," and the results of inoculation experiments support this as applied to Hevea root diseases. It might be argued that if wounds could be avoided, *i.e.*, by covering all laterals, the roots would be immune from attacks. Unfortunately a "wound" in the technical sense, includes any break in the protective covering of the plant. Such breaks may arise in many ways, of which the deaths of very small rootlets is one of the commonest. It follows that although exposed wounds of animal origin should be avoided as far as possible, because of the danger of spore infection, the root fungi cannot altogether be prevented from entering by such precautions.

Before work was carried out on *Poria* and *Ustulina*, it was thought that clean clearing was not essential, the idea being, that trees attacked by *Fomes* died in a relatively short time, so the presence of the disease would be discovered, and the source removed before neighbouring trees had time to establish contact. Also in the

early stages, losses could be made good by supplying, or out of the excess number of trees planted. Bancroft states that this treatment gave very satisfactory results, on areas badly attacked by *Fomes*. Unfortunately, *Poria* and *Ustulina* may go on for very many years, sometimes twelve, without being discovered, and the only safe rule is to treat all timber as a possible source of infection. The possibility of healthy looking trees being in reality diseased is especially serious for existing plantations in view of the very extensive thinning-out now in favour. When it is intended to reduce the number of trees to the acre to less than 80 on plantations which were not clean cleared early, it will be found advantageous to examine the collar and roots of each tree—the expense should not be great. It is often pointed out that the various root parasites cannot be widely distributed in the jungle as this would soon die; it must be remembered, however, that although all these fungi are of comparatively slow growth as parasites on healthy wood, they are capable of very rapid growth on decaying wood, and will spread rapidly once the trees are felled, both under the ground (*Fomes, Poria*) and above it (*Ustulina*).

The ideal time for clean clearing is before planting up—but the removal of large jungle stumps in an undecayed condition entails prohibitive expense. It is, therefore, recommended that the smaller stumps and roots be taken up, while the large stumps be trenched, say with a trench of six feet radius and of a depth sufficient to sever all laterals. Parts of that laterals outside the trenches should be taken up and no Hevea should be planted inside the trenches. As long as the stumps remain the trenches must be kept open. When somewhat decayed, *e.g.*, at the time of thinning out, the stumps may be removed at much less cost.

Care must be taken as long as the stumps remain to examine them for fungus fructifications which should be destroyed as soon as they appear. In a field thus cleared no rubber wood must be allowed to remain. Although the certainty of immunity given by clean clearing cannot be attained later, clearing of timber and stumps will always be found beneficial, except in old plantations already badly diseased (say more than 30 per cent. of trees) there the expenditure could not be justified.

Prevention of spread.—Trenching is recommended for attacks by all root diseases, except perhaps *Ustulina*, for which, according to Sharples, spores from fructifications produced on the surface timber are the chief source of infection. Trenches must be deep enough to sever all lateral roots, and wide enough to include all affected roots; to be on the safe side, another trench should be dug around the neighbouring trees. The diseased trees are best cut out and burnt, the area within the inner trench being dug over to get out all diseased wood. Lime is of beneficial effect if supplying is undertaken.

A careful watch should be kept both on timber and rubber trees and stumps for the fructifications of the fungi mentioned, the most dangerous being those of *Ustulina*, those should be destroyed as soon as they appear. Rubber stumps left after thinning out often bear a plentiful crop of *Ustulina* fruits—the practice of felling trees by severing the laterals has much to recommend it, the roots left behind soon decay, and there is no chance of harmful fungi being harboured.

Admittedly the measures proposed above, involve an increase in expenditure. When considering the benefits conferred by immunity to disease, it should be borne in mind that, given time, contact diseases spread at what may be called "compound interest," *i.e.*, the number of possible infections grows rapidly as the disease spreads out from the centre of the infection.

No figures have been given for costs of clearing, etc., as conditions vary too widely to make comparison reliable; it is, however, the emphatic opinion of the mycologists of the Department that the measures outlined above will be found in every case to be abundantly justified.

Discussion.

The Chairman (Mr. Lewton-Brain) invited discussion of the papers read, and a series of questions was asked, these being subsequently replied to by each lecturer in turn.

Mr. Ellis, of Taiping, next gave his experience of diseases. He was of opinion that if they were going to treat disease at all they should do it thoroughly by cleaning the whole place out and doing away with the whole disease. It was of no use going only half way. Some managers on seeing pink disease appear on their estates naturally said it must have come from the kampongs, but it was just as likely that the kampongs got it from the estates. (Laughter.) Besides that there was the jungle that was a source of infection. When trees were seven or eight years old they were less liable to infection than when they were younger. It was a great mistake to take off a pest gang when the disease was less virulent, and the gang should be kept on always. He referred to bark canker and other diseases that came within his experience, and gave the results of treatment he had applied. He thought the black patch disease was carried by the tapping knife and advised the disinfection of the knife with a solution of 5 per cent. of formalin. The painting with 20 per cent. solution of Izal in black stripe disease was good in same cases, but the point was to let in air and light, good drainage, reasonable thinning out, and then painting with some disinfecting substance.

Mr. Jarvis said that Mr. Belgrave had advised clean clearing before planting but had not made it clear whether he advised timber to be cleared from old estates.

Mr. Belgrave said he would certainly advise such if the disease in the place did not exist badly.

Mr. Jarvis then enquired whether burning of the timber did not do more harm than good.

Mr. Belgrave suggested that burning of the timber in pits be adopted as it had proved very successful on some estates.

Another question asked was did the cutting of roots when clearing timber damage the trees.

Mr. Belgrave was of the opinion that the cutting of a few laterals was not of great importance especially if tar was applied.

Mr. Pinching commenting on the carbolinium solution of 20 per cent. thought it did some damage and recommended not more than 10 per cent. In regard to Mr. Ellis's remark that pink disease should be caught up early enough, he said that that was the trouble, as the disease was not seen until it was too late, and the bark was dead by then. He had heard from the Mycologist in Ceylon that black line canker was not known there, and he thought some explanation was, therefore, necessary in regard to the allusion to that disease being found in Ceylon.

Mr. Pinching also asked Mr. Belgrave as to what depth he considered stumping should be carried out when thinning out.

Mr. Belgrave said that two feet should be sufficient.

Mr. Harrison asked whether timber in peat was liable to carry infection.

Mr. Belgrave replied that one estate on peaty land had suffered badly from root diseases.

Mr. Coombs called attention to flat land and hilly land in their relation to disease. Leaf pruning in America and other countries was not very much advocated.

Another member said that he had noticed trees of seven or eight years old suffer from pink disease. On one occasion Mr. Sharples (the mycologist) and he had examined a large plantation of three- and four-year old trees and found no cases of the disease, but three or four years later he found the disease amongst the then young trees, which seemed to show that the old trees got the disease first, there having been no kampong within a mile of the place. If they said that old rubber was less liable to attack it might make planters neglect their old trees, and that would do more harm than good.

Mr. Richards, referring to Mr. Belgrave's remarks regarding *Fomes*, said it was possible to cure a very large number of cases by looking for the disease by clearing the soil from roots in the case of trees one to five years old and painting with copper sulphate and lime wash.

Mr. PINCHING asked Mr. Richards to express his opinion as to whether he does or does not consider that deep tapping encourages infection by *Phytophthora*—"black thread."

Mr. RICHARDS replied that he had not sufficient experience of the disease to offer an expression of opinion but that he thought deeply tapped trees would not suffer any more severely than those lightly tapped. He added that he hoped no planter present would seriously consider it policy to commence shallow tapping because the question had been raised.

Mr. ELLIS advocated deeper tapping as liable to show disease more easily, besides being more beneficial for latex.

Mr. PINCHING said that Messrs. Harrisons and Crosfield had a solution that was said to be exactly the same as used in Sumatra, but what puzzled him was that they did not get the same results.

Mr. RICHARDS said he had not tried it, and so could not say.

THE DISEASES AND PESTS OF THE COCONUT PALM.

By R. M. Richards, A.R.C.Sc.

(*Mycologist, M. P. A. Association*).

IT is only in recent years that any real knowledge of this subject has been attained. As recently as 1906 Prudhomme stated that "the important enemies and parasites are animals," but there is little doubt that diseases caused by fungi and bacteria did exist years before that date.

It is known that "bud-rot" existed in the West Indies long before the disease attracted any general attention.

The coconut palm in various parts in the tropical world like other plants producing economic products, but unlike the rubber tree up to the present time, has been subject to diseases of an epidemic nature. Climatic conditions in the tropics are so eminently suitable for the rapid development and spread of a disease that at any time any single cultivated plant grown in contiguous tracts of land is susceptible to epidemics, and it is only by exercising the utmost care in guarding against disease that the coconut industry can be maintained.

Warnings such as this have been issued and published by so many workers, in fact they appear in any work dealing with the cultivation in general or with the diseases of any particular economic and widely cultivated plant.

However, such warnings cannot be repeated too frequently and are not to be treated lightly or with contempt; they are not emanations from pessimistic or alarmist minds.

In 1906 a severe epidemic of "bud-rot" occurred in the delta of the Godaveri river, India, affecting palmyra, coconut and areca (betel nut) palms; in the province of La Laguna in Luzar, an epidemic of the same disease affecting coconut palms was reported as having occurred in 1907; and serious attacks have been recorded in the West Indies. *Pestalozzia palmarum* caused an epidemic disease in Kempit in the Banjorwangi Presidency in Java in 1905-6. Either these or some other disease may possibly become epidemic in the Malay Peninsula.

Diseases.

Theilaviopsis ethacetica.—Petch described this fungus as the cause of the "Bleeding disease of the coconut stem in Ceylon." The following is the description of the disease as given by the Ceylon Government Mycologist.

"A brown liquid oozes out through the cracks in the cortex and forms a rusty patch which usually turns brown afterwards. On cutting into this patch, the internal tissues are found to be discoloured and decaying; they are brownish and finally turn black. If the diseased area is cut in wet weather, the liquids sometimes squirts out; in fact, it may in some stages be collected in a glass by simply pressing on the diseased patch. After some time the black patches appear on the trunk, usually on the same side. When this happens, it will generally be found that this is not a new infection, but the disease has worked up or down inside the stem, and the liquid has found a new outlet. . . . It is important to note that there is no sign of the disease until the liquid oozes out, and when this occurs the internal tissue is already decayed to some extent."

On one estate in Perak I have made observations on palms affected by the similar rusty and finally black patches from which a brown liquid oozes. In every way the external and internal appearances correspond with Petch's description but I have never been able to isolate the fungus *Theilaviopsis ethacetica* from the affected tissues.

It is quite possible that this effect is produced by the same cause as in Ceylon but of course no definite statement as regards the disease can be made until the fungus is isolated from diseased tissue and infections are made from the cultures.

By cutting away the decayed or diseased parts of the stem and covering the wound with a very liberal coating of tar it is possible to prevent the patch from enlarging or spreading up or down the tree to other parts. Petch recommended that after cutting out the diseased tissue the wound should be burnt with a torch and then covered with hot coal tar. All diseased parts cut away are burnt, and should it not be possible to apply this local treatment in advanced cases the whole palm should be cut down and burnt.

Pestalozzia palmarum.—This fungus is the cause of a leaf disease in this country as apparently in most parts of the tropics.

Bernard found this fungus to be the cause of a destructive epidemic in the Banjorwangi Presidency, Java, in 1905-6.

In this country as far as my experience goes the disease is only found among young plants either in nurseries or in plantations after planting out. The fungus is extremely common as a saprophyte on dead leaves and the withering lower leaves of healthy palms.

In the first stages little whitish transparent spots appear on the leaves. The spots increase in size and coalesce, forming irregular areas of dead tissue on the leaves. A brown ring surrounds each area immediately outside which the tissue has a pale green or yellowish colour indicating where the fungus is growing into the healthy part of the leaf. The tips of leaflets and edges become

white or greyish in colour. When the effect of the disease is serious the whole leaf becomes yellow and all leaves are affected, and eventually the yellow colour changes to a greyish white and the leaves wither. Sometimes only the latest formed leaf, not yet fully opened, may be seen green and unaffected but this eventually dies and with it comes the decay of the growing point or heart and the death of the palm.

Dead palms should be uprooted and all parts carefully burnt *in situ*. Diseased leaves of affected palms may be cut away and burnt and plants treated in this way should be carefully watched for further signs of the disease.

Fungicides may be applied by spraying but this is only advised when nurseries are affected, more as a preventive than a remedial measure. Bordeaux mixture should be used as the fungicide.

Helminthosporium sp.—This fungus has been found intermingled with *Pestalozzia* and may contribute towards the general effect of the disease. It is possible, also, that this fungus itself is the cause of a disease similar to that of *Pestalozzia palmarum* though I have no records that such is the case.

Botryodiplodia sp.—In December of 1914 a disease was first found in this country which I now attribute to a fungus, a species of the genus *Botryodiplodia*. At one time I thought that this disease was an exaggerated form of attack of *Pestalozzia palmarum* and in a circular letter sent to members of the Association, dated 5th February, 1915, I described the effect of this attack, but in a note at the end of the letter added that *Diplodia* among other fungi was found with the *Pestalozzia* and that I could not then say which fungus was responsible for the full effect of the disease. This letter together with photographs is published in "A Practical Guide to Coconut Planting" by R. W. Munro and L. C. Brown. The first noticeable sign of the disease is that distal end of a leaf withers and droops, almost breaking away from the rest of the leaf at a point of weakness, varying from one foot to three feet from the top, but remaining attached, hangs directly downwards as a pendulous section. These withered ends of the leaves on affected trees are most characteristic in appearance. It is possible at first sight to mistake these signs for attacks of brown beetles or leaf beetles but a cursory examination will prove the presence or absence of the obvious signs of the boring of the beetle. The drooping end of the leaf is at first yellow but finally has the usual brown appearance of a withered coconut leaf. The fungus spreads into the lower part of the leaf travelling down the leaf-stalk and eventually the whole leaf becomes yellow.

As the fungus affects the tissue of the leaf-stalk a brown mark is produced and is especially noticeable on the "lower" or "outer"

surface. If affected trees are not treated at this stage the fungus finds its way to other leaves and the spores quickly spread the disease to other palms.

Soon, the fungus growing rapidly in the tissues after the first stages, all the leaves are killed and hang down alongside the trunk, the leaf-stalks being broken at all positions.

At this stage the youngest leaf is affected, the growing point succumbs to the attack and the palm dies. Almost immediately a bacterial decay sets in in the tissues at the apex of the stem resulting in the production of an evil smelling mass. This is not to be confused with "bud-rot" which is a distinct and specific disease and will be described later. Remedial measures must take the form of cutting away the affected parts of leaves at the earliest stages. It is necessary to look for the brown mark on the leaf stalk mentioned above in the description of the disease and cut away the diseased leaf at a point at least one foot below the proximal end of this mark to ensure cutting at a point beyond the limit of diseased tissue. In all cases this method has proved eminently satisfactory. All diseased leaves and dead palms must be burnt *in situ* and not carried away through the fields to be destroyed in another place. The disease is spread by means of spores which are air-borne. Unless great care is taken in the treatment of the disease local epidemics are caused and many palms may be killed.

It is interesting to note here that Fredholm in Trinidad decided that the rot appeared in two forms: one caused by bacteria; the other following an initial attack by a fungus which he called *Diplodia*. Copeland in The Coconut fully quotes Fredholm's paper. In many respects his account almost describes the effect of *Botryodiplodia* on palms in this country but as I have already pointed out "bud-rot" is an absolutely specific disease in this country. Bacterial decay almost invariably takes places in the apex of the coconut stem after a palm has been stuck by lightning; when red beetles have killed all the forming shoots or when the palm is affected by any disease or pest the final stage is a rot of the apex.

I have stated above that *Botryodiplodia* is the fungus causing the disease but I have no absolute proof that this is the case for I have failed to obtain characteristic results after infection on leaves of young palms. However, I have been able to obtain good cultures of *Botryodiplodia* from portions of affected leaves where no other fungus was present. On dead parts of the leaves many fungi are to be found living saprophytically and among these *Metasphæria Cocoes* and *Pestalozzia palmarum* predominate. Another difficulty is that *Botryodiplodia* is usually a wound parasite and yet many palms in a group may be attacked by this disease. It is possible that there is another fungus associated which is perfectly parasitic in its nature or there may be other agencies.

A vigilant watch must be kept for outbreaks of the disease. By careful work almost all loss can be prevented; by carelessness all affected palms, and perhaps very many in a group or groups, may be lost. The treatment mentioned above is quite reliable whatever the causal fungus may prove to be.

Bud-rot.—Cases of this disease have been reported on several of the estates visited regularly by me.

The characteristic feature of the disease is the rotting of the terminal bud and surrounding soft tissues including the apex of the stem. The first sign is the turning yellowish white of the young leaf which has just opened; following this the central unopened leaf becomes discoloured and in a short time all the unopened leaves and the growing point or apex of the stem decay and putrefy, the whole "cabbage" being converted into a soft, foul smelling, putrid mass. In the majority of cases which I have seen the older leaves appear at the stage when the "cabbage" decays to be quite healthy.

There is no indication of any organism other than bacteria in the affected parts of diseased palms in the Malay Peninsula.

Earle, Smith, Jonston, and Petch all considered that the disease was attributable to bacteria. Butler, the Imperial Mycologist in India, described in 1906 a severe epidemic of disease among palmyra and other palms in the Godaveri district of the East Coast of India. The disease was confined to a limited area in the delta of the Godaveri river. The cause of the disease was stated, as a result of field and microscopic examination, to be a fungus belonging to the genus *Pythium*, a description of which, under the name *Pythium palmarum*, was published in 1907.

All these reports have been made within the last few years. "The History and Cause of the Coconut Bud-rot" by Jonston, published by the United States Department of Agriculture, gives a very full account of the disease, and the author of that paper has shown quite conclusively by repeated inoculation experiments that the West Indian "bud-rot" is due to bacteria almost identical with *Bacillus coli*.

It is believed that birds and insects are carriers of the disease. Whether or not the wounds are necessary for the introduction of the bacterial organisms, which are certainly pathogenic, into the tissue of the plant I am unable to say, Rorer found that he was able to produce the disease by pouring a culture of *Bacillus coli* into the crown of a healthy tree which apparently was unwounded.

When the apical growing point is affected there can be no remedy. To save other palms it is necessary to cut down all dead trees and destroy all affected parts with as little delay as possible. It may not be possible to burn the infected material but every effort should be made to get rid of it. By drenching with Bordeaux

mixture and burying the decayed and diseased tissues with a quantity of lime I think one would apply the second best remedy. Whatever the method, it is of the utmost importance to destroy infected material and so prevent any possible transmission of the disease by insects.

Root disease.—No root disease has been found in this country. Stockdale regarded root disease in Trinidad as the most serious of the three diseases he described—root disease, leaf disease and "bud-rot." Palms exhibiting a wilted appearance with their leaves turning yellow should be examined by an expert. This appearance is not uncommon but I have invariably found that the effect is due either to poor soil or in the cases of some young palms to some unexplained condition.

Meliola palmarum.—A black fungus which causes the sooty appearance is found frequently on leaves.

It has never been found necessary to adopt any remedial measures as the fungus does not permanently damage the palms.

Insects Pests.

Oryctes rhinoceros.—This insect is the common "brown beetle" of the Malay Peninsula or sometimes known as the black beetle.

I need not give any description of the beetle or its mode of attack. Preventive measures are most important and they must take the form of collecting the larvæ of the beetles and destroying possible breeding places. Debris of coconuts should not be allowed to lie about but should be collected and destroyed periodically. Traps have been used on some estates but not with any great success as usually the beetles have a vast number of potential breeding places to choose from. On a clean estate, scrupulously cleared of all coconut debris, traps of the kind used in Samoa, where the beetle was first discovered in 1910 and were supposed to have reached Upolu Island in a shipment of rubber stumps from Ceylon in 1909 or 1910, may give good results and are worth a thorough trial. Copeland gives an account of Freiderich's traps in his book "The Coconut" which is here quoted: "For the making of a trap a hole is dug in the ground from 9-12 feet square, and about 2½ feet deep. Rotten coconut stumps, plantain stems and soil are put into it and over the top large leaves such as coconut leaves and plantain leaves are placed rising perhaps a foot above the surface of the soil. Into these pits the female beetles penetrate to lay eggs and the male beetles to find the females. What beyond digging the traps is necessary is that they should be opened at regular and not too distant periods (six weeks to two months), or that the beetles (and larvæ) in them may be killed in some way."

The leaf beetle, *Xylotrupes gideon*, needs no description. Means of preventing attacks must take the form of collecting the beetles.

Rhynchophorus ferrugineus or R. Schach.—The palm weevil or "Red beetle" as it is known to planters is capable of doing much more injury to the palm than the brown *Oryctes.* Unlike the latter this insect passes through all the stages in its life history on the host plant. The destructive stage in the life history is the larva, not the mature beetle as in the case of *Oryctes.*

The insect is well known and need not be fully described. Preventive measures must take the form of preventing egg-lying and that of destroying the insects whether adult or in the larval condition. All wounds should be tarred, no green leaves should be pulled off as in this process wounds are obviously made, and the burning or scorching of leaf bases and fibrous tissue at the bases of leaves either intentionally or accidentally is particularly deprecated as injuries so caused provide suitable means of entry for these beetles.

Brontispa frogatti (Sharp).—This little leaf-eating beetle of the family *Hispidæ* is quite commonly found on coconut plantations in the Peninsula. It was described by Frogatt as the worst pest of the Solomon Islands in young plantations. This was reported in 1903. Both adult and larvæ feed on the leaves of the coconuts.

Preuss states that it and two other species were known in 1911 in New Guinea, the Bismarck Archipelago, New Hebrides and the Celebes. In New Guinea this beetle is known as the "Heart-leaf beetle." It is a small beetle 7-10 mm. or $\frac{3}{10}$ to $\frac{2}{5}$-inch long by 2 mm. wide. The head is dark brown, the thorax and first legs orange in colour and the rest of the body a shining blue-black." The head is very small, the eyes project in the sides, the front is produced into a lancet-shaped point standing out between the basal joints of the stout antennæ.

The wing covers or elytra are covered with very fine and regular pits arranged in parallel lines. These do not show except under a lens.

The larva when full grown is as long as the adult. It is flattened and usually found closely adpressed to the surface of the leaf. "The head is small, lobed, with short jaws on the under side of the head: the small legs are divided at the extremities, forming two rounded feet. The abdominal segments, eight in number, are furnished in the sides with a slender, rounded, fleshy tubercle; and the anal segment has the tips flattened and produced into a pair of short, incurved, flat calliper-like processes, which curving inwards, form a perfect crescent between them." The beetles crawl into the folded leaflets of young opening leaves and lay their eggs in this position. The adults and larvæ living in between the two halves of the close-folded leaflets eat away the tissues, and as a result the leaf does not open properly and when it does open partially it is malformed, the leaflets have grey brown spots or in bad cases the whole leaf is a dirty grey black and dried up and has much the same appearance as it would have had had it been burnt prior to opening.

In the Solomon Islands tobacco and soap wash is shaken into the still unfolded leaves.

Preuss recommends the use of nitrogenous fertilizers to help trees to resist the attack. The only way, however, found successful is the cutting away of all affected leaves and burning them together with the insects. This method has been successfully employed on several estates where the trees are periodically found affected.

Hidari irava and Erionota thrax.—These two butterflies are the coconut skippers of the family *Hesperiidæ.*

They are very much alike both in appearance and their method of attack. I shall not give any description.

The result of a bad attack, when very many caterpillars are feeding, is that all the tissue of the leaflets, except the midrib and perhaps patches of soft tissue here and there, is eaten away. Almost all the green soft parts of hanging leaves, in fact all leaves except those which are still erect, have been observed to be thoroughly eaten until only a skeleton remained.

The life history of these butterflies is short, from six to eight weeks. It appears that the pests are quickly parasitized as I have no record of a single instance of this pest remaining after the second brood. The best remedial measures, when practicable, are the catching of the butterflies and picking off and collecting the cocoons. Spraying or any other remedial measures have not been found necessary.

Thosea cinereomarginata.—The larva of this moth is a green slug-like caterpillar recognized by having along each side of the body a row of spinous tubercles. Pupation takes place in a hard oval cocoon which opens at one end in a distinct lid for the emergence of the imago. These cocoons are commonly found attached to the under side of leaves of palms.

The larvæ of this pest eat the softer parts of leaflets until as in the case of the skippers mentioned above only the midrib is left. I have seen groups of palms temporarily seriously affected but in this case again I have never thought it necessary to apply remedial measures.

Mahasena sp.—This moth is not a serious pest, and has not been observed to attack more than four or five palms in a group. Only young plants are affected, the larvæ or caterpillars live in cases made up of bits of leaves woven together with silk. The case is carried about on the trees by the insect whose head only appears. Only the male insect attains the perfect or imago stage. The female lays her eggs in her case and gradually shrinks up, as the eggs fill the lower half of the case. The eggs hatch and the larvæ make their own little cases. The old female cases must be carried by wind or other agency to palms, but little appears to be known about his part of the life history.

Brachartona catoxantha.—This moth is a serious pest of coconut palms. The moth is very small, only measuring 16 mm. across the expanded wings or a little less than $\frac{2}{3}$ inch. The limited time at my disposal does not permit a full description.

By the time the fourth generation has hatched the insects have multiplied so considerably that a local epidemic is formed. After the fifth or sixth brood, but this varies according to the development of the insects' own enemies and only two broods may appear, the pest disappears "having become abundant enough to let its own enemies or parasites multiply in excess." The parasites of *Brachartona*, among which the most important is a fungus, *Botrytis* sp., and second in importance a Phorid fly, die off when the pest is nearly exterminated or suppressed and after three years (I have evidence to show that three years, not two years, as stated elsewhere, is the interval of time) *Brachartona* reappears as a pest in the same locality. It appears that on each occasion of the reappearance of the pest in one locality the enemies of *Brachartona* develop with increased rapidity reducing the number of broods and therefore the injury caused by the pest. It is early to be quite sure of the facts in this connection but the evidence obtained so far points in this direction. My experience had been that spraying with either kerosene emulsion or London purple as advised by Pratt, or any other insecticide besides being extremely expensive is of little or no value in eradicating the pest.

The following remedial and preventive measures were adopted on one plantation and had the desired result. All the lower leaves of the palms which have been badly eaten, and on which many thousands of the insects were pupating (still in the chrysalis stage), were cut off and burnt. The lowermost leaves of the trees throughout the area in which the flight had been observed were cut off and piled in heaps for burning, this was done to destroy the eggs laid by the moths. The leaves were cut away and destroyed to decrease the numbers of the larvæ which would have developed had the lowermost leaves been left, the greatest number of eggs being laid on the lower leaves.

As soon as the caterpillars (hatching out from the eggs) appeared and commenced to feed a number of coolies were told off to singe the leaves with torches. The torches were made of long poles with a portion of a coconut husk fixed to one end of each. The husk was soaked in kerosene and lighted. By passing the torches along the under sides of the leaves the caterpillars were either killed by the heat or they dropped to the ground. Immediately the caterpillars fall they endeavour to make their way back to the leaves by crawling along the ground and up the stems of the palms. A ring of tar and grease was painted on the stems about a foot and a half above the ground to catch the caterpillars, and prevent them from again reaching the leaves. This was highly successful, thousands of caterpillars

being caught in this way on almost every tree. Besides the torches we used long sticks for beating the leaves to knock off or shake off the caterpillars. Brushes on long handles were also used for sweeping the insects from the leaves.

All the insects were not destroyed, but that their numbers were greatly reduced was obvious on the appearance of the next flight of moths. Comparatively few moths developed. On the reappearance of the caterpillars the same methods were again resorted to, the whole area showing signs of having been affected being carefully and systematically treated. Three months after my first visit the pest had disappeared. Nets were also used for catching moths.

As regards the damage done to the palms by cutting away or by singeing the leaves I do not think it is at all extensive and the palms recover extremely well.

It should be added that under no conditions should any part of the palms except the leaves be scorched. Copeland refers to the risk of such treatment, if applied to the crown, on account of the probable attacks of the red beetle.

Termites.—Termes gestroi is said to be a serious pest of coconut palms in certain districts in the Peninsula but on the plantations visited regularly by me the pest is little known and the injury caused is correspondingly of small account.

I have seen palms seriously injured by the insects boring into the tissues of the stem. Generally the injury in itself, except in very young palms or unless nothing but a mere shell of the stem is left, need not have a serious effect. It has been advised that lands taken in from virgin jungle and planted up with coconut palms be clean cleared of all timber. Such measures may be necessary where the attacks of white ants are considered serious but such measures are usually most impracticable and there must be strong evidence that the attacks are serious or are likely to have serious results before the planter will be convinced that he should adopt them. I have never had reason to suggest the adoption of these measures and the usual treatment with the exterminator pump has been quite satisfactory.

Scale bugs.—Scale bugs and mealy bugs are found commonly on the leaves of the palm but none of the many species cause any serious injury as far as I am aware and, therefore, they call for no comment here. The sooty mould, *Meliola palmarum*, is associated with several of the scale bugs parasitic on the leaves of the palm.

Rats.—These animals are enemies of the coconut palm and have caused serious loss in certain district in the country.

In February, 1914, Pratt wrote in the *Agricultural Bulletin*: "The position of priority as a really serious pest to young coconuts in

the Malay States must be given to rats. They have caused immense damage in several districts, completely destroying as much as 2,000 acres in one locality. They are not constant in their attack."

In the same article the author referred to these animals nibbling the base of the palms and eventually eating out the heart, "leaving a hole $2\frac{1}{2}$ inches in diameter."

As I have no experience in dealing with this pest, fortunately none of the coconut plantations it is my privilege to visit regularly have suffered attacks of the pest, I think I can do no better than quote from Pratt's article

Protection of young palms.—"Out of a piece of zinc, 18 inches long and 12 inches wide, an arch is cut at the middle of the longer edge, measuring, approximately, seven inches wide at the base, and five inches high. The nut itself fits into this arch and by drawing the tin round the tree a cylinder about five inches in diameter is formed enclosing the base of the young plant.

The base of the cylinder on either side of the arch is buried about three inches in the ground thus enabling the top of the arch to fit tightly over the upper part of the nut. No rat can harm a young plant protected in this way, for if access is obtained by burrowing there is no room for the rat to work within the enclosure."

This method seems to have had successful results.

For older trees possibly an adequate measure might be to surround the stem of each palm near the base with a piece of tin in the form of a cylinder or "with a collar of tin several inches wide and attached so that it slants outwards and downwards from the tree." Such a method is too costly to put into practice unless the pest is causing really serious injury.

THE HISTORY AND PRESENT POSITION OF WHITE ANT TREATMENT IN MALAYA.

By P. B. Richards, A.R.C.Sc.
(*Acting Government Entomologist, F.M.S.*)

ON considering what subject to select, of interest to both the rubber and coconut sections of the planting community, I thought it might not be unprofitable to traverse the history of the treatment of the major pest of plantation cultivation in Malaya, namely *Termes gestroi*, to endeavour to trace the development of knowledge of the pest and of efforts made to combat it, to see, if possible, where the earlier workers went wrong, and perhaps to extract some lesson applicable to the present.

It is probable that there are some here of long experience of Malaya, and of long memory, who would be better able to discuss the historical side than I. For the earlier material I have to depend largely upon the *Agricultural Bulletin* of the Straits and Federated Malay States edited by Ridley. Of the last three years, during which considerable advances towards the complete control of *Termes gestroi* have been made, I venture to think I need make no apology for drawing upon my own experience.

The first printed record of white ants damaging crops is in an article by Ridley in the *Agricultural Bulletin* of the Malay Peninsula No. 4, January, 1895. He wrote: "One constantly hears of coffee and other trees being destroyed by termites, and the informants seem to think that the insects absolutely eat the roots and base of the stem of the living tree, and so destroy it. I have great doubts of this." Ridley's doubts were based upon several observations. He instanced that on opening termite nests, by which he presumably meant mounds or nests in the soil, undamaged roots of plants might be found traversing the nest. He described how termites "usually so induced by a dead bough" throw up galleries along the trunk and attack the bark, and so "by letting the wood suffer from exposure, injure or kill the tree." "But this," he wrote, "is rare and almost invariably occurs in trees dying from other causes." A young clove tree, the death of which was at first ascribed to termites because galleries were thrown up around the base of the tree under which the insects had eaten away all the bark, was subsequently found to have been attacked by a fungus. "As soon as the fungus had practically killed it the termites threw up their galleries and began to destroy the dead part of the tree." Similarly with two young Araucarias, the primary cause of death being starvation through root competition, with a contributing mechanical cause in the compact clay masses of

white ant nests beneath the trees. Ridley then generalized as follows: "Such action is what appears to be generally intended when it is said that a tree is killed by termites, the real cause, being perhaps obscure, is overlooked, and the termites who come to remove the dead tissue are credited with the original injury."

From this article it appears that the typical *Termes gestroi* habit of attacking live trees was not then known. It follows that in 1895 the insect was not a pest of major importance or such a sound observer as Ridley could not have failed to have noted this fact.

It is unlikely that any of the termites observed by Ridley in Singapore up to this time were *Termes gestroi*, and he was probably quite correct in ascribing these particular attacks to diseased conditions. But I think it very likely that his generalization based upon observations of other species was subsequently taken by planters to apply to *Termes gestroi*, and developed into the pernicious idea that the trees lost through white ants would have died anyway, or at best would have been of little use. This fallacious theory of pre-disease has continued almost, if not quite, down to the present.

In 1897, the Linnæan Society published Haviland's "Observations on Termites, with descriptions of New Species." This is the standard scientific work on Malayan termites. Twenty species, including *Termes gestroi*, were described from British Malaya and a further considerable number from the Islands, but they were not treated from the economic side. *Termes gestroi*, however, received considerable attention because "the species is one which deliberately attacks and destroys live trees." The soldier, upon which classification is based, was described in detail, and shorter descriptions given of the workers and nymphs—that is, the winged individuals which develop into kings and queens. Unfortunately, Haviland did not obtain the adult king or queen, and from his failure to find them came to the conclusion that "the same colony often possesses several nests, only one of which is inhabited by fertile individuals whose eggs and young are carried to the other nests." My own experience does not bear out the whole of this. Subsidiary nests are made by *Termes gestroi*, in its feeding places but I have never seen eggs in these. Always the parent nest alone contains the eggs, and every nest containing eggs contains also the queen. Of the habits of *Termes gestroi*, Haviland wrote: "This species is remarkable for its habit of killing live trees. It encases the trunk for a distance of eight feet from the ground, with a thick crust of earth. Under cover of this crust it eats through weak spots in the tree to the heart of the wood, which it excavates, forming there a kind of nest built of wood fibre."

Next in chronological order is a further article by Ridley in May, 1900. A brief description of the soldier is followed by an

account of the attack upon trees which is almost identical with Haviland's account, stating, as he did, that the nest is formed of wood fibre inside the attacked tree.

That *Termes gestroi* was increasing in importance as a pest is evident from Ridley's comments upon the failure of treatment, consisting of scraping down the mud casings and treating the injured surfaces with tar or substances injurious to the insects. Ridley also observed that he had received from Selangor "specimens found destroying Para rubber trees."

It should be noted that both Haviland and Ridley say nothing of the whereabouts of the source of the attack—that is, the parent nest. The subsidiary nests described are obviously one of the sequelæ of the attack.

It is a great pity that the nesting habits of *Termes gestroi* were not then determined as valuable years were lost before more definite knowledge was published and applied. Had planters then known where the parent nests were to be found, and how successfully the pest could be treated through these, *Termes gestroi* might never have been given the opportunity to multiply and establish itself as a pest of such enormous importance.

Nowhere is the copy book maxim "prevention is better than cure" more truly applicable than in the province of economic entomology and to no insect more aptly than to *Termes gestroi*. But for either it is essential to have an accurate and full knowledge of the habits and life history of the insect; efforts at both prevention and cure were shortly made, but without the essential knowledge they were foredoomed to failure.

The unfortunate lack of information about *Termes gestroi* in the early days is in my opinion one of the gravest misfortunes suffered by the Malayan Para Rubber Industry; not alone, or mainly, because thousands of dollars were wasted, and trees lost, but because fuller knowledge would have induced the employment of sound measures of timber treatment, and clean clearing, with all its accruing advantages might have become as much a *sine qua non* of rubber cultivation as clean weeding.

The next two publications threw little further light on the subject. In October, 1901, W. W. Bailey contributed a report in which he describes "Termites" as the worst enemy of his rubber, eating out the heart of his healthiest and best rubber trees. Having tried arsenic, sulphate of copper, phenyl, tuba, kerosene oil, etc., without success, he decided to set coolies on to digging out queens and breaking up the mounds, although he says he had been told by more than one scientist that the queen of the rubber termite was not to be found in mounds. The queens were taken from mounds one to two feet high and each man averaged ten a day. "It may be said," he wrote: "That they are not termites, and it may be true; but one

thing I am certain of, and that is that they are identical with, the creature that is destroying our rubber trees . . . I feel certain that I shall almost exterminate these insects on my estates."

In the light of present knowledge it is obvious that to whatever else species the queens belonged which were dug out of the mounds, they were not *Termes gestroi*, and that not by this method was there any hope of protecting the rubber trees.

In November, 1901, Ridley, writing upon a recent visit to Selangor, expressed his admiration of the splendid coffee and Para rubber trees he saw, but "the drawback was the white ant pest, and it was truly grievous to see fine four-year old Para rubber trees killed by their attacks." Suspecting fungus disease in addition to termites, several trees were pulled up and their roots examined. On one a fungus was found and identified as *Helicobasidium* sp. Ridley observed "I am aware I am on debatable ground as to whether the particular tree I examined which had fungus at its roots was killed by that fungus or by white ants or by both . . . My own theory is that in this particular instance the fungus was the cause."

In a letter from Lanadron in December, 1901, Francis Pears wrote: "The age of my trees is from $2\frac{3}{4}$ years downwards and as yet I have not had a single established plant destroyed by white ants, although certain portions of the estate contain numerous ant heaps such as Mr. Bailey describes; on one ten-acre block as many as two hundred. This, Sir, may slightly bear out your theory that a fungus is principally instrumental in destroying the trees in Selangor."

I believe I am correct in saying that Lanadron was clean cleared of timber before planting. What an epoch making letter that would have been if Pears had deduced the true reason of his freedom from white ant attack, that the absence of timber precluded the possibility of attack by *Termes gestroi*.

E. V. Carey in March, 1902, gave what should have been the death blow to the system of destroying queens from mounds. He described how, having in the pre-rubber days paid out considerable sums in rewards for queens because *Termes gestroi* was attacking the coffee, he submitted some specimens to E. E. Green in Ceylon, who, of course, told him that he was catching the wrong species. Later, when Para, rambong, and coconut were attacked "roots were bared and kept open to the air, painted with tar, washed with Bordeaux mixture, solution of tuba root, sweet flag, Jeyes disinfectant, etc.," without success. Then Bailey of Lowlands tried another method which had met with such "unqualified success" that Carey ascribed to him the credit "of having put us all on the right track." The method was a thorough digging over of the whole attacked area. Carey recommended a modification, contenting himself with digging from attacked trees, $2\frac{1}{2}$ to 3 feet deep for a distance

of not less than 10 feet in every direction, and further following the runways up to the nest and destroying the queen. Even if the nest were not found, the disorganization of the runways was held to be sufficient to prevent the termites returning to the same tree a second time.

It could not be long before this method discovered its weakness. The only effect upon the attack would be to drive it to fresh trees. Moreover, many attacked trees would go untreated because, as Robinson was soon to point out, in a considerable percentage of cases there are no external signs of damage.

By far the most important thing in this article of Carey's is the following note in parenthesis: the nest "is almost always found in a log or the stump of an old tree." It is amazing to me that not until another six years had elapsed was this knowledge applied by treating timber, and that a further six years was allowed to pass before clean clearing as the only perfect treatment for *Termes gestroi* was seriously supported by any of the men engaged in agricultural research in this country.

The first serious attempt to investigate the pest was made by Robinson, now Director of Museums, whose account is published in the *Bulletin* in December, 1904. I can do little more than indicate some of the more important features, and recommend you to re-read the whole for yourselves. A simple key to the species commonly found on estates is followed by a good account of the nests of the mound-building species. The useful part played by these species in converting timber into available plant food is pointed out, and the futility of treating them insisted upon.

Termes gestroi, Robinson remarked to be rare in Nature, and ascribed its abundance on estates to the stimulus provided by unusual quantities of suitable food in the form of rubber trees. The first detailed account is given of the external attack under cover of the mud casing, under which, sooner or later, a non-resistent spot in the bark is reached, through which "the whole body of termites gains access to the interior of the tree which is rapidly eaten out." Robinson also was the first to point out that a large percentage of attacks are made below the soil level, no external signs of damage showing. He opposed the theory of antecedent disease, but pointed out the likelihood of *Termes gestroi* effecting entrance through wounds. The remedies of the time are discussed and dismissed as failures with the exception of powdering the collar and roots thickly with freshly slaked lime after scraping off the incrustation. For the treatment of internally attacked trees an ingenious application of CS_2 vapour is suggested. But there is not a word about destroying the nesting sites. Robinson wrote: "The nests are contained within the trunks of the trees attacked, and are formed of narrow labrynthine chambers of woody and earthy matter . . .

the whole of the interior of the tree being more or less filled up with this material." Now, this is typical of the subsidiary nests made in live trees where *Termes gestroi* is feeding, and it is probably such nests that Robinson explored and described. Robinson found one nest out of many investigated which contained eggs—that is, a parent colony. Personally, I have never found a parent nest in live rubber, although such do occasionally occur in old rubber where surface timber has gradually rotted away. Always the parent nest has been in a log or stump. One might search long in attacked young rubber trees for a parent colony without success, but if such were found it would only serve further to obscure the general truth. Carey's clue of the logs and stumps was not followed up, and this otherwise valuable report is marred by the failure to provide that most desirable of all information, the location of the main nest.

In April, 1906, E. P. Stebbing, Forest Zoologist in India, entered the discussion because of specimens sent from Mergui Estate. Stebbing, who, of course, had no first hand knowledge of living *Termes gestroi*, urged the need for procuring full information upon its life history. Among points which he indicated as requiring elucidation, there are two of vital importance—namely, "Where do the termites found in the nest in the crown of the root come from in the first instance?" and "Are there any galleries radiating from the nest to other parts of the plantation? If so, where do they go?" Now this is the first consideration of the problem by a trained Economic Entomologist, and it is interesting to note that at once the true line of investigation was suggested.

In May, 1908, Pratt supplied the material for answering Stebbing's questions in an interim report upon his termite work. Tracing back runways from 15 or 20 eight-year old rubber trees, all of them terminated in a nest, about two feet in diameter, constructed round a buried stump. In this nest was discovered the first authentic queen. Runways ramified from the main nests, broadening out in places to form large open spaces from which branch burrows diverged, the larger of these leading to subsidiary nests inside stumps, logs, and fallen trees. This was indeed an important verification of Carey's statement, and laid the foundation of a rational method of treatment. Pratt pointed out that the age of the rubber, and the nature of the soil had little, if any, effect upon the incidence of the attack, but what really mattered was the presence of timber. The supposed deadly effect of lalang upon *Termes gestroi*, he rightly ascribed to the general absence of timber on old lalang areas. Further promise of being on the right track at last was given in the following passages: "The most important point in connection with the present abundance of *Termes gestroi* . . . is that it attacks dead as well as living wood . . . . The fact that it is among the dead wood, and rapidly multiplying has been ignored. It is only when the rubber trees are being attacked that any measures are

taken against its ravages." Pratt then pointed out how useless it was to treat individual trees while there was a constant supply of termites from the nest-log or stump.

Unpublished correspondence of about this date shows that one estate on old lalang land had never been troubled by *Termes gestroi*. The inference would appear obvious, from the presence of *Termes gestroi* in timber and its complete absence in timber-free land, that clean clearing was the soundest treatment for the pest. Whether this inference was made, and dismissed as impracticable for reasons of expense, there is nothing to tell us. Instead Pratt recommended as "preventive measures" the piecemeal method of tracking down the nest by following runways from attacked trees, and a selective method of dealing with timber. Among native timbers known to harbour *Termes gestroi*, kumpas, meranti and pulai were given the place of honour. It was recommended that these should not be destroyed at first, as "they subsequently afford means of locating *Termes gestroi*," and should then be destroyed with the termites.

Now these methods predicate, before treatment, the establishment of colonies in the timber, and probably serious attacks upon the rubber trees. Surely this is not preventive treatment. Treatment after attack may result in eradication, but preventive measures should leave nothing to eradicate.

To Towgood, in March, 1909, belongs the credit of first advocating the preventive destruction of all nesting places.

After pointing out that white ant timbers varied with locality, he went on to describe methods applied successfully by himself. In old rubber these consisted of collecting and destroying all surface timber, and if then there were further attack, to follow the runways down to its source, which was invariably in a buried log or stump, and to burn the whole nest.

One field of six years old Rambong was interplanted with Hevea, and white ant attack on both was particularly virulent. Five months before writing Towgood had cleared the field of all timber, and no sign of the pest had since been seen.

In many young clearings, the timbers suitable to *Termes gestroi* were sought for line by line, sawn through, and burnt if the pest was present.

For future clearings, Towgood recommended felling the favourite white ant trees first, and allowing them to dry prior to felling and burning the rest of the jungle. In this way he hoped to prevent *Termes gestroi* ever getting established.

Now these are all much sounder methods, but naturally they entail greater immediate capital expenditure. Against this Towgood pointed out that in addition to the satisfaction of knowing that the

only troubles they feared—namely, white ants and *Fomes*, were eradicated, there would be less subsequent expenditure in pest work, supervision would be more efficient, weeding costs less, and all work carried out in the clearing would be cheaper.

Towgood, then, advocated clean clearing old rubber, destroying trees which contain *Termes gestroi* in young rubber, and selective burning in future opening. The first was sound. The others were dangerously incomplete even against *Termes gestroi* alone, not to mention *Fomes* and the later discovered root diseases, *Sphærostilbe*, *Ustulina*, and *Poria*, because any remaining suitable timber in the young rubber might later become infected by *Termes gestroi*, and in the new clearings there is a much greater variety of potential *gestroi* timbers than Towgood suspected. A letter from Johore in December, 1909, lists a further 19 timbers harbouring *Termes gestroi*, Terentang heading the list with over a hundred nests in 40 acres, but the other 18 equally capable of serving as a nidus for *Termes gestroi*, if the favourite timber is absent. The only sure guarantee against *Termes gestroi* attack is to remove, not only every certain, but every possible nesting site. Nevertheless, Towgood was on the right track, and had his advice been followed, improvements in details would have developed.

But just now the sulphur arsenic fumigator was being boomed as a cheap and effective method of treatment. Everybody was wanting a remedy easy of application, certain of result. A prize of £5,000 was offered to the inventor of such. It was not awarded, but public attention was focussed on patent methods, and the universal exterminator was certainly the best of these. And so, unfortunately for those estates now suffering from the many ills bred of rotting timber, clean clearing was set back a further six years.

In October, 1908, Pratt was transferred from the Medical to the Agricultural Department, and devoted some time to the continuation of his white ant work. You are all familiar with the results as published in *Bulletins*, Nos. 1 and 3, of the Department of Agriculture. The first was largely a revision of the report previously considered. *Bulletin* No. 3, which deals mainly with treatment, is too long for me to discuss in detail.

In blocks in which the jungle had been felled less than six years, Pratt advocated isolating attacked areas by a four-foot drain, digging over the soil to a depth of three feet, and burning all the logs and stumps containing *Termes gestroi*. He did not recommend destroying all logs and stumps but said that the proportion which needed removal was comparatively small. As an alternative method, equally effective and cheaper, to be used whenever possible, he strongly recommended fumigation with sulphur-arsenic fumes. The nest having been located, presumably by inspection, a trench was to be cut round it, left open for a few days to allow repair of the

runways, and then nest, runways and attacked trees were to be thoroughly fumigated. "If a little care and interest are taken" he wrote, "and the treatment carried out as it should be, not only would the cost be very small, but the trees within this area will not again be troubled by *gestroi*."

In older clearings, originally planted with rubber, Pratt considered that in all except peaty soils, most of the timber would have become too rotten to harbour *Termes gestroi* and the nests would have been transferred to the rubber trees. All trees suspected of being hollow were to be bored and fumigated, and any remaining hardwood logs which contained nests were to be destroyed.

In peaty soils, which frequently contain much buried timber and roots, fumigation was to be used wherever possible; if it were not successful recourse must be had to the isolating drain and deep changkolling. Thus was the fumigator given official benediction as the premier method against white ants, and clean clearing relegated to the background with scarce even a nod of recognition.

This bulletin concludes with an exhortation to planters not to be unduly alarmed for the future, inasmuch as, although it is wise and profitable to treat the pest, "there must inevitably result a steady diminution of *gestroi*, among the older rubber," except on peaty soils. Such a disparagement of the danger would in itself have been enough to deter planters from recommending expenditure on clean clearing.

From this time onwards more and more reliance was placed in fumigating, generally with incomplete results. Those planters who tired of the fumigator, usually fell back upon local applications of poisons, with worse results. The pro-fumigants held that lack of success was due to inefficient application of the method, and that with trained gangs and competent supervision all would be well. Late in 1914, I had my first experience of white ant work, and went about an enthusiastic exponent of the fumigating school, but before the middle of 1915 I was satisfied that fumigating, although the best of the palliatives, was at best but a palliative. Perfectly applied by perfect coolies, it might keep the attack down to a minimum, but who possesses the perfect coolies? Was there not some other more effective remedy to be deduced from our fuller knowledge of the life history of the insect?

In nature, under jungle conditions, *Termes gestroi* is a rare insect as compared with many other local termites. It is established in certain dead or dying trees. At certain times there is a flight of sexed individuals from the nest, any pair of which can found a new colony, provided suitable conditions—namely, shelter and dead wood. In the jungle such suitable conditions are seldom met, but on a clearing with quantities of unburnt wood, suitable nest sites are abundant, and even if one favourite type of timber is absent, another

can be made to serve. Hence from one mature colony, inside or just outside a clearing, a considerable percentage of the logs and stumps may be infected. Allow one or two years of undisturbed development, and you have numbers of colonies at great strength, ready to attack rubber or any other suitable material, or to spread the infection by swarms of flying individuals to uninfected areas or logs. Trenching, digging, poisoning, fumigating, tracing runways, and numerous modifications and combinations of these had been tried and found incapable of eradicating the pest. Deep changkolling over attacked areas had been abandoned—if it was ever tried—probably because of the cost. In some places the surface timber was being hunted through for nests, the logs cut open and the queen sought and killed. As it had been frequently stated that *Termes gestroi* had not the power possessed by a lot of species of elevating baby commoners to the position of temporary queen, this looked likely at least to stop any further development of those nests. But this method had soon to be discarded also, as I found, in the remnants of such colonies, substitution queens raised either from undestroyed eggs or very young individuals. It was, therefore, obvious that the whole nest must be destroyed so that no remnant capable of raising substitution queens was left; and not only the nest, but the containing timber, lest later some members of a nuptial swarm should find it a suitable place in which to settle and recommence the trouble. But if in the remains of the nest log, why not in other timber also. So long as suitable timber is left, even if all the *Termes gestroi* in the clearing have been destroyed, the conditons approximate to those of an uninfected new clearing, and in one night a nuptial swarm may reinfect the whole area.

I was thus driven to the conclusion that the only safe preventive and remedial treatment for *Termes gestroi* was absolute clean clearing.

During 1915 I was able to test the method on a peaty block suffering from the heaviest pure *Termes gestroi* attack I have seen. Surface timber was destroyed, stumps were blasted and lifted, and buried logs were prospected for with probes, dug out, and burned. The work was done thoroughly, and the result was excellent. One or two small areas showed re-attacks which were traced to hidden logs, but after these were taken out, no further white ant trouble arose in the block although previously the mortality ranged up to 75 per cent. of the 18 months old rubber. The method, then, was sound, but what of the expense? Would it really pay the average estate to put up the necessary money? I had faith that it would, considering the crop saved, and the reduction in working costs effected, so thereafter, whenever called upon to advise on white ant treatment, I insisted upon the fundamental importance of destroying timber. Some estates provided for the work—others carried on with careful application of their previous methods. But during 1914-15

our knowledge of the mode of attack of certain fungi upon the roots of rubber, and of their immense economic importance, was rapidly advanced, and the responsibility fixed upon decaying timber. With this extra, and even more important case against timber to support the policy of clean clearing, it became possible to advocate as a general estate method what previously might have been considered a counsel of perfection.

In February of last year at a Planters' Association lecture I first recommended the general adoption of this common-sense method. The idea did not at once meet with unanimous approval, but the progress it has made in little more than twelve months has been eminently satisfactory.

Early in 1916, also, I had the opportunity to devote some time to the consideration of coconut pests, and here too *Termes gestroi* proved to be by far the most serious pest, warranting a very considerable expenditure upon preventive treatment.

The same arguments for clean clearing apply to coconut cultivation as to rubber, beetle grubs in the rotting wood replacing fungoid diseases as the supporting reason.

That clean clearing is the only sure cure for *Termes gestroi* attack, I am fully convinced. Of all other methods tried, including the sulphur arsenic fumigator, it must be admitted that they have failed to eradicate the pest. In areas wherein *Termes gestroi* has become established, particularly in old rubber, the fumigator is indispensable, but only as an adjunct—not as the principal method. Within two, or at the outside three years of felling, every available shelter for *Termes gestroi*, and consequently every likely infection centre for root diseases should have been destroyed.

That clean clearing is in general worth while from a financial view point, I am satisfied also. But this is a matter upon which the economist and not the scientist will decide.

To the practical planter belongs the solution of the problem, how best and cheapest to get rid of the undesired timber; whether by double felling; by single felling and clean clearing before planting; by single felling and clearing when the rubber is well up; by disposing of the wood for charcoal or firewood; or what not! The sooner the cheapest and the most effective method is established, the earlier will this, the most desirable of all plant sanitation methods, become a piece of the established routine of estate opening.

APPLICATION OF THE AGRICULTURAL PESTS ENACTMENT.

By F. W. South, B.A.
(*Chief Agricultural Inspector, F.M.S.*)

Introduction.

CULTIVATED crops in any country are liable to two classes of diseases, those occurring in the country, and those introduced from outside. In order to provide means of controlling these two classes of disease in the Federated Malay States, the Agricultural Pests Enactment was passed in 1913 and became law upon its publication in the *Gazette* on 1st August of that year.

The Enactment.

The main provisions of the Enactment provide for the control of diseases occurring in the country while powers under a certain section enable the Chief Secretary to make rules for preventing the introduction of pests into the Federated Malay States, by prohibiting the landing from places outside the States of any plant or animal likely to introduce a pest and by providing for the treatment or destruction of any plant or animal which has been landed and of the packages, cases, pots or covering in which the same may be contained.

As the known diseases of rubber are common to practically all rubber producing countries in the East, it has not been considered necessary to ask the Chief Secretary to provide any rules in connection with the importation of plants, especially as such importations are not at present extensive in the Federated Malay States.

The measures for the control of such diseases as already occur or may arise in the future may be divided into two classes.

(*a*) Those requiring the treatment of specifically diseased cultivated plants and

(*b*) Those requiring the removal of conditions suitable to the introduction or spread of any pest.

The details of these measures are now well known and it is not necessary here to enumerate them, suffice it to say that they involve the employment of a special staff of European officers and Malay subordinates who are invested with the necessary powers, including powers of entry on cultivated land, of removing portions of infected plants for examination and of serving legal notices requiring the carrying out of definite instructions for the treatment or control

of any pest or for the removal of conditions liable to favour the introduction or spread of any pest. Failure to comply with such instructions may be dealt with in two ways:

The inspecting officer with the permission of the Director of Agriculture may institute criminal proceedings involving a fine on conviction; he may also enter the land with assistants and carry out the measures required, subsequently recovering their cost by civil suit.

A further measure in the case of emergency is that the Director of Agriculture, with the approval of the Resident, may place in quarantine any land or any part of land on which diseased plants have been found, and so long as this land is in quarantine no plant or part of a plant may be removed from it except with the permission of an inspecting officer. The Enactment further contains special clauses relating to locusts and the control of the beetle pests of the coconut palm.

Staff.

The foundation of the necessary staff was already in existence when the Enactment came into force as powers as inspecting officers under the Enactment were given to the Assistant Inspectors and Sub-Inspectors of Coconuts who had previously worked under the Inspector of Coconut Plantations, Mr. L. C. Brown. On the retirement of the latter his duties devolved on the Chief Agricultural Inspector to whom control of his former staff was also given.

Certain additional European and subordinate officers were appointed and all subsequently had to be trained in that part of the work relating to rubber for which purpose a certain amount of time was, of course, necessary.

Inspection Work in the Kampongs.

When work under the Enactment first commenced two outstanding matters required attention—namely, the beetle pests of coconuts and pink disease of rubber.

Coconut beetles—Owing to the enforcement of the Coconut Trees Preservation Enactments which were in force previous to the passing of the Agricultural Pests Enactment, the measures necessary for the control of coconut beetles were well known to the majority of the Malay subordinate staff and of the small holders in the kampongs. The continuation of this work was, therefore, a matter of routine, involving no particular difficulties. It had been insisted on for some years and the small owners were accustomed to carry out the simple measures required of them by the inspecting officers; a certain number of prosecutions were, however, necessary in order to maintain efficiency.

Owing to the rise in the price of rubber towards the end of 1915 and the continued high price during 1916, there was a general tendency in both these years to cut out coconuts interplanted

among rubber trees and even to clear land containing mature coconuts for the purpose of planting rubber. These conditions emphasized the importance of the coconut inspection work as the coconut refuse, if left lying about, would have provided an opportunity for a rapid increase in the number of the red beetles. This was avoided by regularly insisting on the destruction by burning or burial of the trees cut out. During 1915 a few serious local outbreaks of black beetles, particularly at Kuantan and Seremban, called for special attention. No serious outbreaks were recorded in 1916. At the present time the Seremban trees have been free of beetles for over a year and have much improved in appearance.

Pink disease—In contrast to the routine treatment of coconut beetles that of this disease had to be commenced at the very beginning. The disease was practically unknown to small owners throughout the country and was of comparatively recent occurrence; moreover, it is not one which frequently results in the death of a tree: for these reasons its importance was not generally recognized by Asiatic owners, while at the same time the subordinate inspecting staff, of whom the majority had only worked on coconuts and the remainder were newly appointed, were not acquainted with its various manifestations. It was decided, therefore, to allow a period of twelve months to elapse before taking legal action to insist on its control. During this period the subordinate staff were taught the symptoms and treatment, small holdings were regularly visited and their owners were shown how to recognize the disease and what must be done to control it.

The actual method of treatment recommended was to cut off the diseased branches well below the last signs of infection and to burn the diseased portions immediately. Smooth cut surfaces subsequently treated with tar were required. Owing to the care necessary when treating this disease with tar, as is done on the majority of estates, it was not considered a suitable method to recommend for use in the kampongs.

At the beginning of 1915 it was thought that a sufficient period of education had elapsed, and the measures previously recommended for treatment of this disease were subsequently insisted on by law. The routine inspection work once commenced was carried on steadily throughout 1915 and a large number of cases were taken in Court. Owners were, on the whole, however, very slow in recognizing that it was to their interest to carry out the instructions given and though a considerable number of fines were inflicted there did not appear to be much improvement in the way in which the work required was actually done. Throughout 1916 the regular treatment of this disease has been insisted upon, and, though an improvement is noticeable in certain districts the disease has undoubtedly spread, and in other neighbourhoods there is practically no improvement in

the present condition of the kampongs. The Asiatic does not see the necessity for treating a disease which does not often kill the tree and which is not eradicated by the most careful and steadily continued treatment. He regards the measures required of him as a nuisance, since they involve work to which he is not inclined, and also as being inefficient inasmuch as they do not result in the disappearance of the disease from his plantation. As a result he prefers paying a small fine of from $2 to $10 inflicted on him by the magistrate to expending the same sum in carrying out the treatment required.

The alternative course of action open to the inspecting officer—namely, of carrying out the work in the small holdings and recovering the cost would involve the employment of such a number of gangs of trained coolies and trained mandors, as is at present entirely beyond the resources in European supervision of this Department. All that can be done at present is to use coolies to treat the disease in such of the small holdings as are most seriously infected and have been most consistently neglected.

The satisfactory treatment of pink disease in the kampongs in general can, in the writer's opinion, only be attained as a result of a comparatively lengthly educational process which will gradually accustom the owners to do what is required of them and lead them to recognize that the measures are for their own good. A state of things ultimately should be obtained comparable to that which exists in the routine control of coconut beetles. Attempts to hasten unduly the educative process necessary are certain to be without effect, and only patient and continued efforts will have a lasting result.

The degree of attention paid to instructions varies considerably in different States. In Perak where the disease is most prevalent the instructions receive but little attention. In the one badly infected district of Selangor instructions are often obeyed fairly well especially when a large fine is inflicted from time to time. In the Negri Sembilan the disease is much less prevalent and often disappears entirely for a portion of each year even in those districts which are comparatively the more infected. The occasional cases found have mostly been treated as required. In Pahang work is being somewhat newly commenced and not much can be said about it at present.

Lalang.—Shortly after inspection work commenced, it became evident that the lalang so often present on small holdings should be removed, irrespective of whether these contained rubber or coconuts, more especially when they bordered on clean estates or other clean holdings. In this case also it was decided to commence by giving advice only, until the small owner should become more accustomed to an idea which is entirely contrary to his usual happy-go-lucky methods.

Legal action to enforce removal of lalang, particularly from holdings bordering on estates or other clean holdings, was commenced in 1915 in the States of Perak and Selangor. During 1916 this action was continued steadily and a certain number of cases were instituted in Pahang; in Negri Sembilan no legal action has yet been inforced, reliance being placed entirely on the advice of the inspecting officers, which is fairly frequently adopted especially by Chinese. The process of educating the small holders to realize the importance of doing the work necessary to keep his land free from this serious pest, which not only itself damages the rubber tree but is frequent source of almost entire loss though fire, will be as slow as that of teaching him to treat pink disease and is again to be arrived at only by gradual and steady education.

These then are the three main lines of action which have been followed during the years 1915 and 1916, and the number of court cases which have been taken in connection with them are given in the following table:

Coconuts.

State.	1915.		1916.	
	Total cases.	Total fines.	Total cases.	Total fines.
		$ c.		$ c.
Perak	146	484 50	139	826 00
Selangor	38	134 50	88	488 00
Negri Sembilan ...	56	406 50	39	151 00
Pahang	2	10 00	8	22 00

Pink Disease.

		$ c.		$ c.
Perak	225	1,717 50	348	3,979 50
Selangor	2	10 00	6	300 00
Negri Sembilan ...	...	...	1	10 00
Pahang	1	5 00	...	...

Lalang.

		$ c.		$ c.
Perak	14	107 50	39	332 00
Selangor	1	5 00	16	59 00
Negri Sembilan ...	...	...	...	...
Pahang	...	...	67	98 00

Tapping.—Almost from the beginning of the inspection work the European officers have given advice to small holders all over the country as to proper methods of tapping. During 1915 and 1916 steps were taken to train the subordinate inspecting officers in good methods of tapping and advice as to reasonably conservative systems of tapping allowing a satisfactory bark renewal has since been freely given in all the kampongs by them. At the same time common errors in tapping, resulting in waste of bark, and the serious damage done by severe wounding, have been carefully pointed out. This advice was most urgently required as, on the older holdings in particular, the yield is often reduced to as little as 100 lbs. per acre per annum owing to excessive tapping in the past which has left the trees with a bark so thin that, properly speaking, it should not be tapped at all. Again in many instances previous severe wounding has left the surface of the bark so burred and rough that it is no longer tappable. The advantage of this advice can be clearly seen in parts of Pahang on small holdings which were opened in 1915 and 1916 under the advice of the local sub-inspectors. These trees have not been nearly so severely damaged as have those in some other parts of the State where they are three or four years older. The matter of giving advice as to tapping systems on small holdings is of very great importance, especially in view of the very large area of young rubber recently planted, which will be continuously coming into bearing in the future especially in the years 1919 and 1920 when the large plantings of the past two years will probably be opened. It may be mentioned that two court cases were taken, one in Perak and one in Selangor, during 1916 for failure to obey instructions to improve tapping methods on certain holdings where the whole of the bark had been removed practically down to the wood. It is held that a large number of trees in this condition are exceptionally liable to disease and might serve as a source for its rapid spread. Elsewhere, however, advice on this subject has been fairly welcome and has been followed fairly willingly.

Removal of Dead Rubber Wood.—The result of the Mycologist's work on *Ustulina zonata*, the black line fungus, especially emphasized the importance of removing from small holdings all dead rubber wood, trunks or stumps, irrespective of whether their presence is due to death from disease, damage by wind, or thinning out. Four cases resulting in fines amounting to $30 were taken in Selangor in 1916 in this connection. This is a point which will receive further attention during the coming year.

Black Stripe Disease.—The most recent disease found to require attention in the kampongs is the "black stripe" disease of renewing bark. This disease was known to occur on certain estates in Perak and is now under investigation by the Mycologist who is also conducting experiments to determine its control and treatment. Up to the month of March last, the disease was not known definitely to

occur in kampongs anywhere, but during that month it was found fairly commonly on kampongs in the Raub district of Pahang by the Assistant Agricultural Inspector, Selangor, and the author. The treatment of this disease in the kampongs will be a difficult matter and can only be carried out by a trained gang or gangs of coolies specially employed by the Department. Both the identification of the disease and its treatment require more or less expert knowledge and the Malay subordinate officers will have to be most carefully trained before such work can safely be left to them.

Steps must, however, be taken early to decide the distribution of the disease in the kampongs and measures must be devised for its treatment.

Locust Work.

In Selangor and the Negri Sembilan the Assistant Agricultural Inspectors have been responsible for supervising the work of destroying locusts, for which purpose a special staff was provided. The work commenced in September, 1913, and continued in Selangor until the end of 1915. A few locusts were present during 1916 and a small staff was kept until the end of the year to watch them. No eggs were, however, laid and the State is now practically free from locusts; unless there is still a small swarm rapidly dying out at Sepang; none are known to occur elsewhere. In the Negri Sembilan work went on continually during the years 1913, 1914, and 1915; the staff was reduced in 1916 as the number of locusts became less and only part of the subordinate staff was left under the direct control of the Assistant Agricultural Inspector. Naturally the locust work occupied much of his time in 1916. At present there are no more locusts in the Negri Sembilan and very little more work is expected there.

The Chief Agricultural Inspector has been in chief control of this work throughout; besides general supervision of this work in Selangor and the Negri Sembilan since August, 1913, he has also had to supervise work on locust destruction in Johore since October, 1914, and in Malacca since March, 1916. In both these States the number of locusts is now much reduced.

Work on Estates.

The work of European inspecting officers on estates has been almost entirely of an advisory nature. In two or three cases letters requiring the treatment in accordance with the Enactment of one or two diseases, usually pink disease, have been sent out, but in no instance has a court case been necessary to enforce the measures required.

As part of the routine work the distribution of pink disease by mukims has been determined and practically every infected estate is known in Perak, Selangor and the Negri Sembilan, in Pahang the

work is not yet complete. Practically all infected estates have been visited at least once, often more frequently, and have been given advice as to treatment of the disease.

The black line disease, *Ustulina zonata*, being comparatively new, has given planters some trouble and many have asked the inspecting officers to visit their estates and given advice about it. It is now fairly well known and on many estates the removal of all timber, especially thinned out rubber stumps and trunks, is being carried out on all the older fields. The question is under consideration as to whether the inspecting staff ought not to use its powers to require the removal of at least all dead rubber wood from all estates in the interest of the industry as a whole. This treatment would apply also to the other root disease of older rubber, *Poria hypolaterita*, about which advice is often asked.

White ants, *Fomes*, *Sphærostilbe repens*, die-back, drying up of latex and various bark troubles all give rise to requests for advice from time to time and inspecting officers are more and more frequently asked to visit estates to advise on the treatment of one disease or another.

Recently, that is from the middle of 1916 to date, much attention has been given to two bark diseases. The first is the "black stripe" also known in Perak as "cambium rot," first found in Perak North. The Assistant Agricultural Inspector, Perak North, has, I believe, determined its distribution on estates fairly fully in his portion of the State and is also assisting the Mycologist with experiments to determine its treatment. This disease, occurring as it does on renewing bark is a very important one, and work on its distribution in other States has been commenced. It is known to occur here and there in Selangor in the districts of Kuala Selangor, Klang and Ulu Langat and in the Raub and Kuantan districts of Pahang. So far it has probably been recorded from the Negri Sembilan only on one estate, as it seems preferable to consider the bark disease known there on several other estates to be different, since it exhibits certain differences in symptoms and may not be due to the same fungus.

The second bark disease referred to is this form found in the Negri Sembilan. Its distribution on estates has been fairly fully determined by the Assistant Agricultural Inspector, Selangor, and the Assistant Agricultural Inspector, Negri Sembilan. On the suggestion of the management tapping was stopped on one area in which this disease occurred.

Census of Coconut Trees.

It may be mentioned in passing that a full census of coconut trees on small holdings has been nearly completed by the inspecting officers and that the advisability of making a census of rubber holdings to show ages and trees is under consideration.

Conclusion.

It will be seen that the activities of the inspecting staff are fairly numerous and show every prospect of increasing largely in the future. Nearly all the lines of work are of considerable importance, as I think will be readily admitted, and new methods of dealing with new diseases may become necessary as time passes and local fungi become more and more adapted to rubber as a host plant. If all these known and possible future diseases are to be kept well under control, the inspecting officers will be kept busy, and in fact the work that is even now necessary bids fair to grow beyond the capacities of the present subordinate staff, so that a scheme for increasing it in the near future is being drawn up in order to keep pace with the needs of small and large planters.

Even the short experience so far available seems to indicate the real value of inspection work for disease control, though the full results obtainable can only be arrived at slowly after many years of careful and patient educative work.

Discussion.

Mr. Coombs asked Mr. R. M. Richards whether he had in his experience met actual cases of death of coconut palms which could be assigned to *Pestalozzia* and whether under conditions obtaining on the best estates here it was not advisable to leave the palms to recover from the disease themselves. Also if from the point of view of general sanitation it would be advisable to remove the tree creeper so common in old palms.

Mr. R. M. Richards replied that he had seen rare instances of grown palms which had succumbed to *Pestalozzia* attacks. In cases of attacks of this disease in nurseries it was not advisable to leave matters to chance. In reply to the second question he did not consider it necessary to clean up the creeper (a fern) from palms as he had never found the creeper causing injury.

Mr. P. B. Richards asked Mr. R. M. Richards whether he had tried spraying with contact poisons applied with a power sprayer, for the destruction of *Brachartona*.

Mr. R. M. Richards said that he tried all forms of sprayers, except a power sprayer, and found that spraying was inefficient. He stated that singeing and hand collecting was, in his opinion, the only way of dealing with the pest.

Mr. Vaughan Smith asked Mr. South what steps had been taken to control coconut beetles in the kampongs in the Bagan Datoh district.

Mr. South replied that the usual routine inspection had been carried out throughout last year and a few cases had been taken in court in most months of the year, but the results were not very satisfactory and the Assistant Agricultural Inspector was intending to give the matter his personal attention this year.

Export of Rubber from British Malaya (other than F.M.S.).

State.	Month.	Quantity.
		lbs.
Johore	...	...
Kelantan	...	...
Kedah	January, 1917	942,776
Perlis	January and February, 1917	4,575
British N. Borneo ...	„ „ „	932,820
Brunei	„ „ „	50,376

FEDERATED MALAY STATES.

Comparative Statement of Cultivated Rubber Exported, with Value and Duty Collected thereon, during the Years 1917 and 1916.

Destination.	Exported during March, 1917.	Previously.	Total export during the year.	Export during similar period of previous year.	Increase.	Decrease.	Value of rubber exported, 1917, to date.	Value of rubber exported during similar period of previous year.	Duty collected, 1917, to date.	Duty collected during similar period of previous year.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	$	$	$ c.	$ c.
Straits Settlements ...	5,182.60	9,579.01	14,761.61	10,195.35	4,566.26	...	38,656,686	31,242,237		
United Kingdom ...	1,793.07	3,269.18	5,062.25	3,531.48	1,530.77	...	13,286,290	10,762,313		
Continent of Europe	...	...	...	...	...	...	...	...	2,697,067 03	1,117,201 40
Ceylon	110.51	81.71	192.22	229.05	...	36.83	529,279	687,256		
Other Countries ...	2.14	315.47	317.61	151.42	166.19	...	801,653	452,264		
Total ...	7,088.32	13,245.37	20,333.69	14,107.30	6,263.22	36.83	53,273,908	43,144,070	2,697,067 03	1,117,201 40

KUALA LUMPUR,
11th April, 1917.

E. BURNSIDE,
Acting Commissioner, Trade and Customs, F.M.S.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of February, 1917.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bharu	...	141.0	78.2	84.53	70.14	14.39	73.8	.751	70.7	77.	...	11.93	.80
Pahang, Kuala Lipis	...	...	77.35	86.6	72.1	14.5	74.11	...	...	...	...	5.29	1.4
Johore, Johore Bharu	...	...	...	84.03	72.07	11.96	...	...	...	...	...	15.71	
Singapore, Kandang Kerbau ...	29.808	163.0	79.50	85.30	72.60	12.70	75.96	.846	...	83.3	...	10.51	3.62
Malacca, Durian Daun ...	29.879	137.5	80.4	84.9	70.6	14.3	77.8	.915	...	88.	N.E.	12.83	2.44
Negri Sembilan, Seremban ...	...	153.3	77.7	86.2	70.6	15.6	73.8	.768	72.6	82.4	N.E.	11.18	4.17
,, Kuala Pilah ...	...	137.0	84.3	88.4	70.6	17.8	77.6	.903	75.8	86.6	...	7.83	2.04
,, Port Dickson...	...	...	79.0	84.9	72.3	12.5	75.6	.821	73.7	83.0	...	8.07	1.96
Selangor, Kuala Lumpur ...	29.767	139.1	80.2	81.9	72.9	9.0	75.1	.794	71.8	75.	N.E.	7.51	2.51
,, Klang	...	...	78.5	84.1	71.4	12.7	75.2	...	...	...	...	8.07	3.46
,, Kuala Selangor ...	...	...	...	86.8	73.3	13.5	...	...	...	...	...	9.37	3.30
,, Rawang	...	...	...	91.5	...	...	...	...	...	...	...	7.08	1.92
Perak, Telok Anson	...	...	79.73	91.0	69.0	22.0	75.84	.843	...	84.	...	11.22	2.20
,, Ipoh	...	...	80.67	92.0	68.0	24.0	75.12	.798	72.63	76.	...	8.33	2.24
,, Taiping	...	113.0	79.78	91.0	69.0	22.0	75.57	.827	...	82.	...	30.15	4.72
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	26.37	3.74
,, Parit Buntar	...	...	81.38	93.0	69.0	24.0	76.41	.846	...	80.	...	9.88	2.71
Penang Georgetown	29.778	133.2	83.	89.6	72.5	17.1	77.5	.838	74.	78.	S.E.	4.29	1.22
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	3.99	1.71
Perlis, Perlis	...	...	...	88.50	70.46	18.04	...	...	...	...	...	1.45	